Grinding and Finishing

WHEELS • GRINDING • HONING • LAPPING MACHINES • ACCESSORIES • PORTABLE GRINDERS • TUMBLING • ABRASIVES

The Magazine Devoted Exclusively to Abrasive Operations

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★ FEATURES

Belt Grinding Gas Turbine Parts at General Electric —Page 13

Can Small Plant Grinding Operations Be Automated? —Page 18

What Constitutes a Fair Day's Work? —Page 22

Optical Measuring Machine for Inspecting 3-Dimensional Cams —Page 38

COPY SENT TO L. C.

ALSO IN THIS ISSUE

Shop Hints and Kinks
Safety
Letters to the Editor
Free Literature
What's New in Equipment and Materials

AUGUST 1956

CLEAR·COOL·CLEAN and NO ODOR

A "clean deal" with 3 MOTCH & MERRYWEATHER PRODUCTS

TRIPLE C GRINDING COOLANT

Transparent solutions; watch work progress. Soluble in water; no emulsifying action. Maximum cooling. Grinding wheels stay clean and free-cutting; minimum wear and dressing. No disposal problem. No slippery work-pieces. No foaming. Non-flammable. *No objectionable odor,* even in hottest weather.

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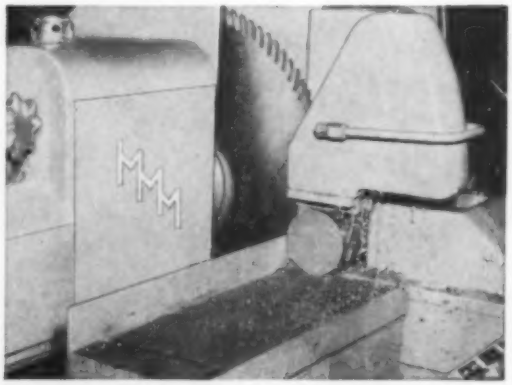
Extreme pressure lubricity lengthens tool life. Transparent, water-soluble, non-oily, non-greasy. Non-gumming, non-galling, anti-rust, friction-reducing. Foamless, smokeless, vapor harmless, no skin infection; no fire hazard. Agreeable odor — *never foul.* A definite aid to production and accuracy.



Also TRIPLE C MACHINE CLEANER

Dissolves accumulated insolubles in coolant systems; cleans thoroughly at lowest labor costs. All Triple C advantages: Clean, Cool, Clear; safe, preventing bacteria at source. And *never a foul odor.* Your men will like it!

A good coolant works best in a clean machine

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Cutting Tool Manufacturing Division

Stocking Dealers in All Principal Industrial Centers

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Grinding and Finishing

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List of Hitchcock Representatives on Page 39.

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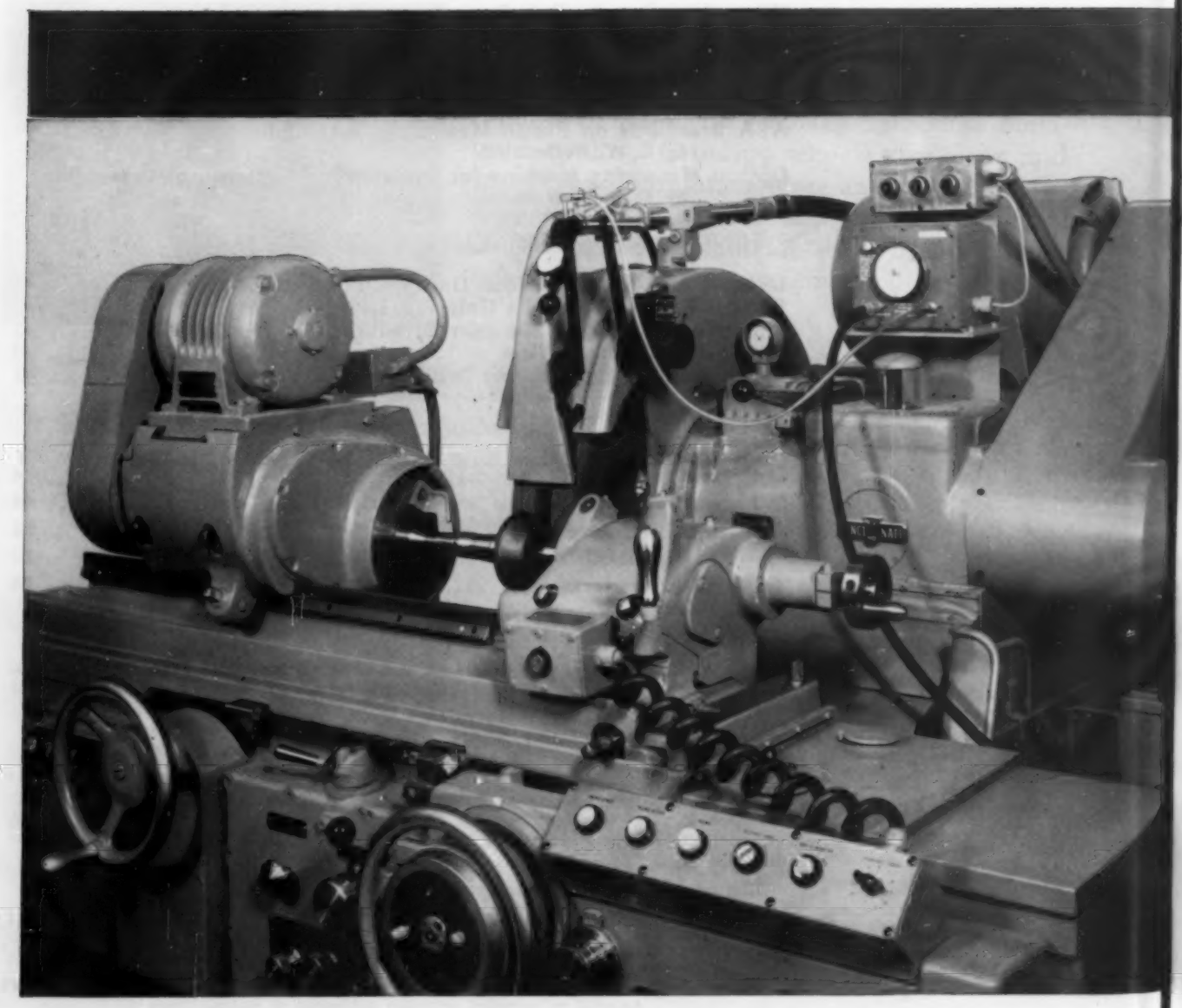
You Gain Two Advantages

FILMATIC

- **Automatic Air-Electric Gage**
- **Cycle Time Automatically**

CINCINNATI FILMATIC 10"R Plain Hydraulic Grinding Machine, equipped with Automatic Air-Electric Gage Sizing.

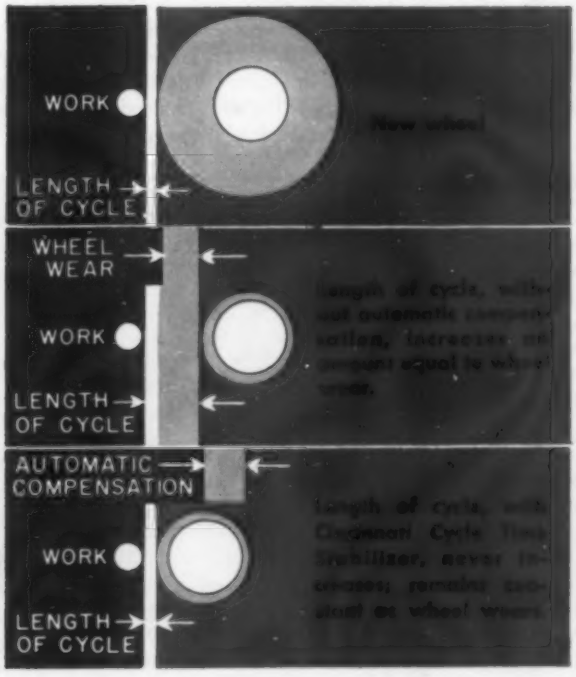


. . . with Cincinnati Automatic Gage Sizing

Control of Accuracy

Stabilized

CYCLE TIME STABILIZER
an exclusive feature of Cincinnati Automatic Air-Electric Gage Sizing.

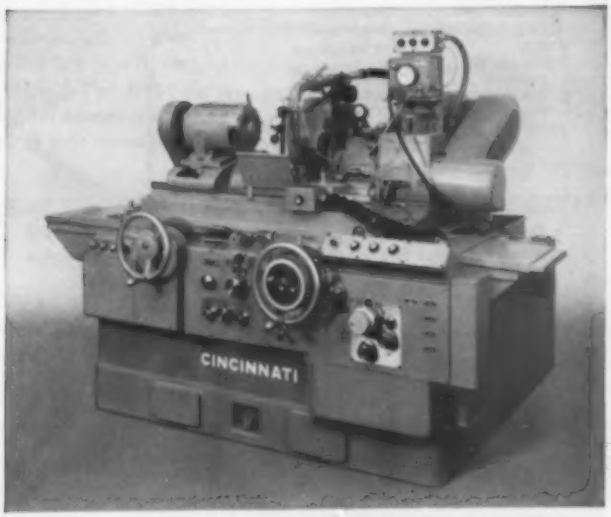


Now you can discard the box formerly reserved for rejects from infeed grinding operations. Just assign your precision infeed work to CINCINNATI® FILMATIC Plain Hydraulic Grinders equipped with Automatic Air-Electric Gage Sizing. This not only eliminates rejects of undersize work, but you gain an important secondary advantage:

> Rate of production remains constant as the grinding wheel wears. The Cincinnati Cycle Time Stabilizer feature automatically compensates for wheel wear, maintaining a constant length of infeed cycle, with no attention or manual adjustment whatever.

You can have Automatic Air-Electric Gage Sizing, with its exclusive Cycle Time Stabilizer, on any new CINCINNATI FILMATIC 6"R, 10"L, 10"R, 14"L Plain Hydraulic Grinder. In conjunction with other outstanding Cincinnati advantages such as FILMATIC grinding wheel spindle bearings and automatic wheel balancing, Cincinnati offers top value for precision grinding operations. Our field engineers and sales representatives want to tell you more about these Cincinnati features and how they will reduce costs in your shop.

CINCINNATI GRINDERS INCORPORATED
CINCINNATI 9, OHIO



CINCINNATI FILMATIC 6"R x 18" Plain Hydraulic Grinding Machine equipped with Automatic Air-Electric Gage Sizing, with its exclusive Cycle Time Stabilizer. Complete information in two publications: G-603 and G-638. Write for your copies.

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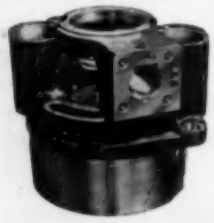
Why TECUMSEH Compressor Crankcases Are MICROHONED

"On Tecumseh compressors, we Microhone the piston bores. ***This gives us a running seal between pistons and bores which prevents gas leakage and eliminates the need for piston rings!*** Believe me, it takes a real combination of accuracy and functional surface finish to get results like that . . . and only Microhoning has given us that combination!"

(Tecumseh Products Company, Tecumseh, Michigan, is the world's largest producer of refrigeration compressors. Precision engineered and processed these units are hermetically sealed before leaving the factory.)



OTHER JOB DATA:

MATERIAL	Cast iron
PRECEDING OPERATION	Diamond finish-bore
MICROHONING OPERATIONS	One
STOCK REMOVAL	.0007" to .001"
FINISH	10 Microinches
TOLERANCES	
Diametric	.0003"
Roundness	.00015"
Straightness (Taper)	.00015"
HONING CYCLE	18 seconds, including fixture indexing time

"Here's our twin cylinder crankcase. The two piston bores in each case are opposite one another in the vertical plane, but they lie in two different horizontal planes. We simultaneously Microhone both bores in each crankcase, using a horizontal type machine with two opposing spindles."

"Although all of our crankcases are similar in design, the bores vary in diameter—1.312", 1.375", 1.500" and 1.625". Two fixtures on a two-position rotary indexing table let us Microhone one crankcase while another is being loaded. To run different bore diameters we just change the tools and gage rings. Switchover time is about five minutes."

Let a Micromatic Field Engineer show you how Microhoning will give you better functional finishes, closer tolerances and higher production.

☐ *Please have a Micromatic Field Engineer contact us.*
☐ *Please send literature and case histories on Microhoning.*

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Letters to the Editor

Pressure Blast Your Carbide Tools

As pioneers and originators of the fine particle abrasive wet pressure blasting process generically referred to as Vapor-Blasting, may we express interest in your recent editorial entitled "Pressure Blast Your Carbide Tools" in the June, 1956, issue of GRINDING and FINISHING.

Our experience has been that when Vapor-Blasting has been substituted for other inspection methods, the cracks and fissures are truly discernible with the naked eye; consequently, photos of Vapor-Blasted carbide tools require no retouching as evidenced by the herewith submitted photograph.

I would like to point out at this time that we have on many occasions processed carbide tools which had previously been checked by Magnaflux and Zyglo and we have exposed minute fissures, which were not apparent after inspection by both of these methods. One logical explanation for this phenomena is the fact that during the Vapor Blast process, the hydraulic action of our fluids and abrasive flush fine sintered material out of extremely minute fissures, which are filled during the tool grinding or sharpening process due to heat and pressure.

If a surface is previously finished to approximately 5 microinch rms, it is possible with the use of the finest abrasive material for wet blasting available in this country, namely, our theoretical 5000 mesh or Micro Mist which has

a major particle size of 3 microns, to change this surface appearance from a high lustre to a very fine satin matte finish and retain the 5 microinch finish as measured by a brush analyzer or profilometer. It may be possible by using reduced air pressure and smaller quantities of abrasive in suspension, to maintain a 4 microinch finish after Vapor Blasting. However, I will definitely state that the retention of a 2 microinch finish is theoretically impossible unless only water were employed and such an operation would have no merit.

H. F. Patin, Sales Mgr.
Vapor Blast Mfg. Co.
Milwaukee, Wisconsin

We're glad to have Mr. Patin's comments.

Diamond Dressing Tools

We would like to distribute reprints of the recent article on Diamond Dressing Tools to our various agents throughout the country. If you have 25 or 50 of these available, we would appreciate receiving copies for this distribution. If they are not available, please let us know the cost involved in preparing reprints.

D. H. Ruth, Adv. Mgr.
Landis Tool Company
Waynesboro, Pennsylvania

From India:

We beg to refer to your note given in the March issue of your magazine under the heading "Reprints Available." We will be pleased to have the following literature:

1. **Abrasive Grains** by Joseph I. Forrester.
2. **Where and How You Can Use Abrasive Rolls** by Robert McAdams and James L. Erickson.

We hope you will let us have the above reprints at the earliest. Thanking you,

Krishnalal Thirani & Company, Ltd.
8 Royal Exchange Place
Calcutta, India

Sent to India: the last of our reprints on Abrasive Grains.

Barrel Finishing

We have an issue of your magazine for November, 1955 in which there was an article by Morris S. Shipley and William A. Biebel of the Esbec Barrel Finishing Corp., Byram, Conn. We would like very much to get all five parts of this article or the issues of your publication that contain this article.

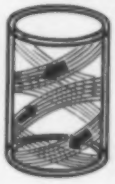
We would like to subscribe to the magazine. We are a machine shop and do much finishing. Please bill us as

How MICROHONING Makes a Gas-Tight Running Seal Without Piston Rings

A leak-free, running seal between bores and pistons—without the use of rings—is possible only when the processing method generates diametric and geometric accuracy and the required functional surface finish. These characteristics are simultaneously obtained by the Microhoning process. Here's how:

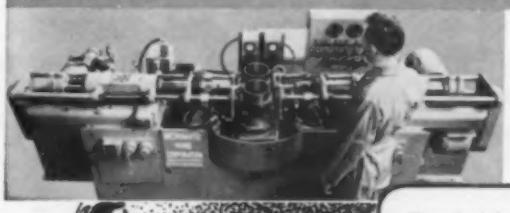
1 The sticks of abrasives in the tool form an abrasive "cylinder" and are fed out radially with equal pressure in all directions. High spots and tight areas in the bore are abraded first.

2 The long abrasive sticks cut only on the crests of wavy or snaky surfaces until the bore has the same diameter throughout its full length.



3 The combination of tool motion (rotation and reciprocation) and feed pressure fractures the abrasive grits that have become dull, and new sharp edges are formed; the clean constant cutting action of every stroke on the full bore length consistently generates the desired surface finish.

One of the exclusive advantages of Microhoning is its ability to produce whatever functional surface characteristics are required for maximum product performance. Microhoning's cross-hatch pattern, with its myriad of minute intersecting "valleys," furnishes an excellent surface for retention of lubrication.



"Here's one of two Micromatic Model 523-2 machines used on the compressor crankcase job. Tecumseh uses a total of 18 Microhoning machines on other vital processing operations."

The principles and applications of Microhoning are thoroughly explained in an informative 16mm., 30-minute sound movie, "Progress in Precision." We'll be glad to reserve a print for your use. Just tell us on the coupon the date you'd like to see it.

☐ Please send me "Progress in Precision" in time for showing on _____ (date)

☐ Please send literature on Microhoning. I am interested in the following application: _____

NAME _____

TITLE _____

COMPANY _____

CITY _____ ZONE _____ STATE _____

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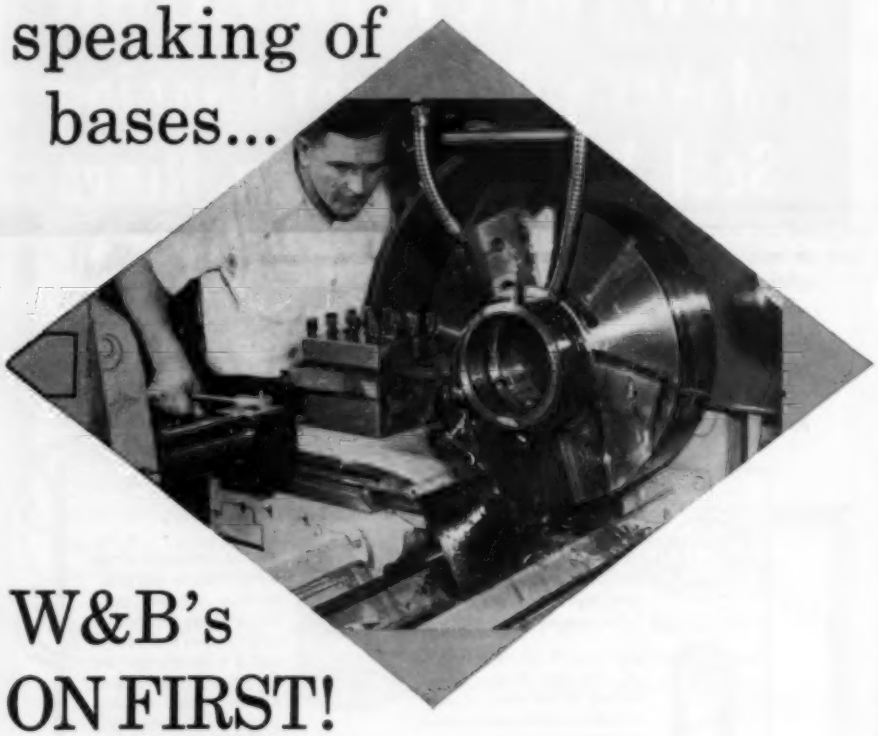
speaking of bases...



W&B's ON FIRST!

W & B Base L, for instance, is the popular choice of top production engineers and shop superintendents where greater potency in cutting and grinding oils is required for certain operations.

When tool life and finish are not satisfactory, ready-mixed oils may be fortified with W & B Base L to produce the desired results.

Product of almost 70 years of White & Bagley industrial lubricant and coolant "know-how", Base L has an outstanding record of proven effectiveness.

Production men using a variety of cutting and grinding oils in quantity have found that they can slash costs and reduce inventory by using Base L to blend or to fortify oils for machining, grinding, drawing or stamping.

Base L, a sulphurized fatty base, carefully manufactured under close laboratory inspection and control, is but one of the available W & B Bases. Special Bases to meet unusual requirements will be prepared on order in minimum commercial quantities, without extra charge.

For more complete information on W & B Bases, write for catalog page B-1 or call in a White and Bagley industrial representative to discuss any phase of your industrial lubrication problems.

THE WHITE & BAGLEY CO.
Worcester, Mass. Established 1888 Detroit, Mich.
W+B INDUSTRIAL LUBRICANTS
Originators of Grinding Lubricants

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there are no rate quotations in your magazine.

E. M. Barrett
El Sereno Machine Works
Azusa, California

Reprint sent and letter referred to our Circulation Department. Reprints are available on Precision Barrel Finishing at 35c a copy.

Shoulder Grinding

Mr. Christopher H. Hill's article on "Shoulder Grinding," was both interesting and informative. The information should be of real help to the maintenance department, and to the operator.

When Mr. Hill covered our territory, we found his knowledge of wheels and grinding were very helpful.

Your magazine is excellent, and I see to it that our operators have the chance to read it.

P. H. Root, V. Pres. & Eng., Grinder Div.
The Fate-Root-Heath Co.
Plymouth, Ohio

Standard Data Series

. . . will you kindly send me two sets of reprints of the "Development and Use of Time Standards from Standard Data Grinding Operations. . . ."

B. E. Reeves, Indust. Eng.
Woodbridge, New Jersey

. . . would you please send me a copy of "How Grinding Standards Are Established with Standard Data?"

I missed seeing the magazine issue which contained the article. The information should be very useful in estimating grinding costs and planning new grinding facilities.

John W. Love, Methods Engineer
Aircraft Engine Div. Ford Motor Company
Chicago, Illinois

By reason of popular demand, reprints are being made of Ed Cyrol's series on Standard Data and they will soon be available.

Designers! Look at Grinding

. . . one of our men in the field has asked for some reprints of your editorial in the May, 1956 issue entitled "Designers! Look at Grinding."

Can you send me a dozen or so copies. . . .

John T. Schenck, President
The Engelberg Huller Company, Inc.
Syracuse, New York

Glad to oblige!

YOU FIND SAVINGS IN EVERY HONED HOLE

One way or another . . . Sunnen Honing will cut your production costs:

1. It eliminates chucking and set up (you often complete the job in less time than required to set up other machines).
2. Interchangeability of honed parts makes assembly of mating units faster, easier.
3. In many cases, honing eliminates grinding, broaching, double reaming and finish boring.
4. Increases production when used **for final sizing** of holes partly completed on automatic machinery . . . eliminates bottlenecks.
5. Does not require expensive skilled labor.
6. Assures longer product life with less maintenance.

TODAY'S TOLERANCES AND FINISHES CALL FOR HONING

LEARN HOW SUNNEN HONING CAN HELP YOU CUT PRODUCTION COSTS

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☐ *Have engineer call for free demonstration*

☐ *Send case histories and technical information*

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VAN NORMAN

New

The new Van Norman No. 2C Grinder is *engineered* for fast, accurate, economical grinding of parts. Incorporated in the many outstanding features is the *15 HP* main drive motor which provides ample power for every grinding job. Couple this with the totally enclosed rugged grinding wheel spindle and you get close-tolerance smooth finishes plus chatterless, trouble-free operation.

Compare These Outstanding Features

- Hard chrome plating of regulating wheel slide after hand scraping, preserves original factory built-in accuracy.
- Grinding wheel and regulating wheel spindles are of a unit type construction . . . totally enclosed with double-row super-precision bearings, sealed and lubricated for life, assuring chatterless trouble-free operation.
- Spindles require no warm-up period, eliminating "creep" which has always been a problem in grinding operations.
- Infinitely variable regulating wheel drive.
- Totally enclosed fan cooled, dynamically balanced 15 HP main drive.
- Independent hydraulic wheel truing devices for each wheel.
- Fine hand wheel adjustment on diameter of work piece.

Phone, wire or write for full details on the new Van Norman No. 2C Centerless Grinder.

Grind Parts Like These Accurately, More Economically

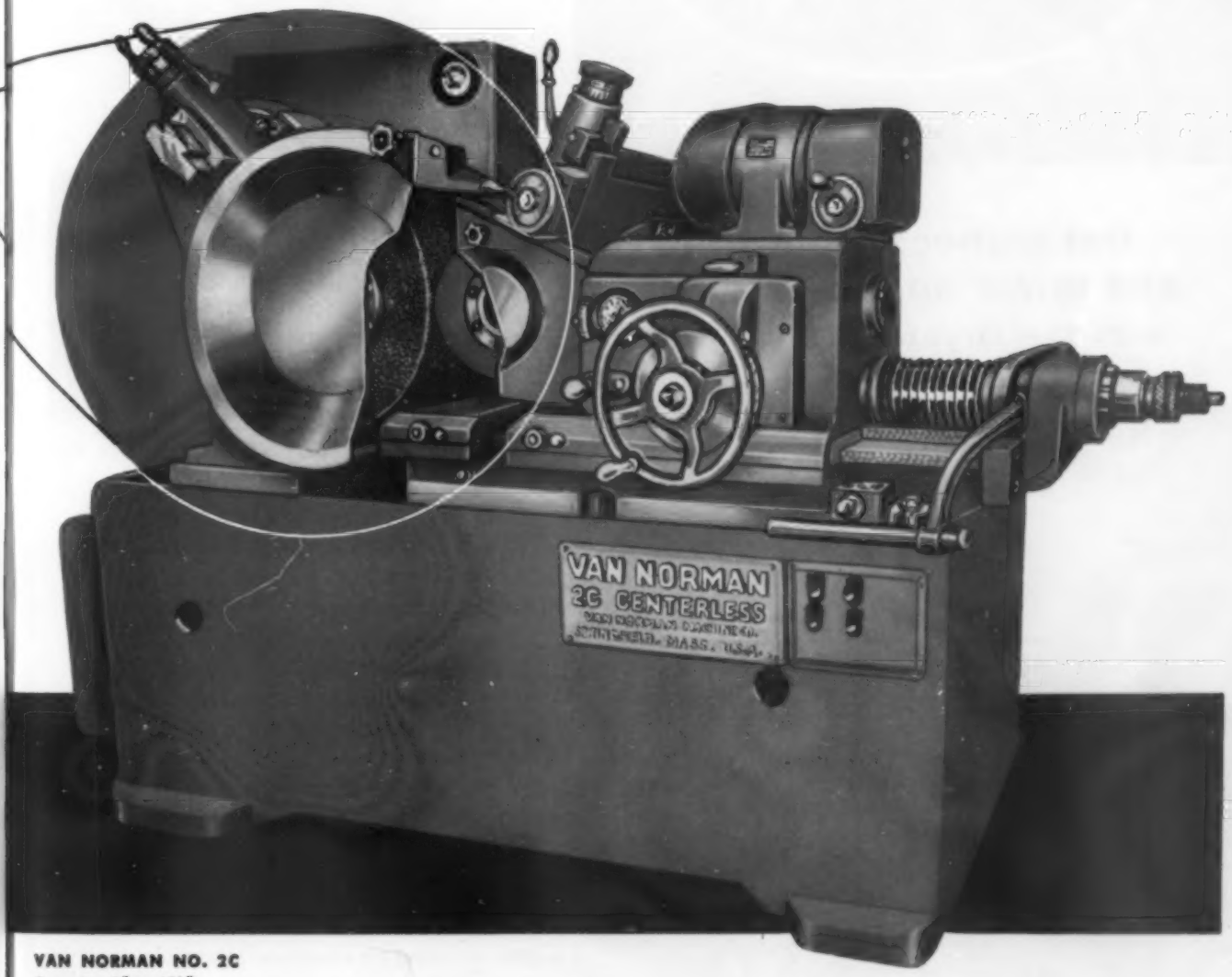
VAN NORMAN MACHINE

MANUFACTURERS OF — Ram and Column Type Milling Machines, Cylindrical Grinders, Spline and Gear Grinders, Oscillating Radius Grinders, Special Production Grinders, Centerless Grinders.

No. 2C Centerless Grinder

...Features 15 HP Main Drive

Assuring Precision, Close-Tolerance Grinding



VAN NORMAN NO. 2C
Capacity: 0" to 4¾"
Grinding wheels available: 24" x 4" x 12"; 24 x 6" x 12"; 24" x 8" 12"
Regulating wheels available: 12" x 4" x 5"; 12" x 6" x 5"; 12" x 8" x 5"
Automatic cycling and gauging available.

Don't wait . . . for extra profits install a Van Norman Machine now!
They are available on many purchase plans — Outright sale . . . Purchase on conditional sales contract up to 5 years . . . Pay as you depreciate . . . See your dealer or write Van Norman Company. Conditional Sales Contracts not available to Export.

COMPANY | **SPRINGFIELD 7, MASSACHUSETTS**

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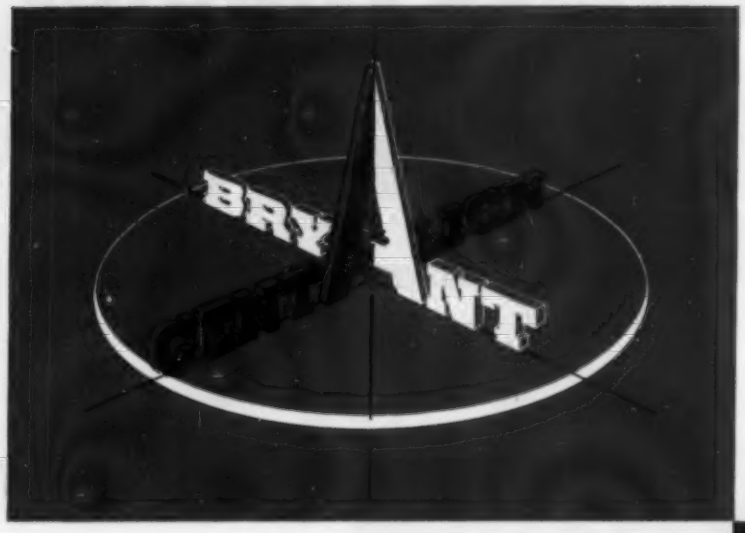
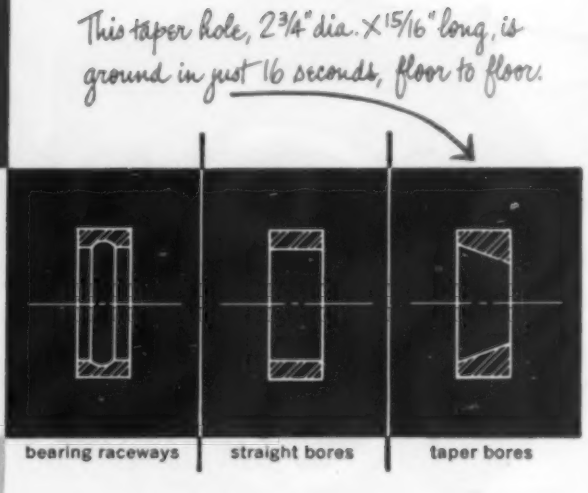
VM 6-20



Get higher production and lower operating costs with the Bryant "Centalign"


This taper hole, 2 3/4" dia. X 15/16" long, is ground in just 16 seconds, floor to floor.
bearing raceways
straight bores
taper bores

Just 16 seconds, floor to floor, to remove .018 stock to close tolerances. One more proof that the "Centalign" will remove stock up to 50% faster than heavier conventional type machines.

The completely new construction of the "Centalign" offers you unprecedented production rates, continually accurate production, and reduced operating costs because it incorporates such features as **1.** All loads and controlling forces on a common plane, reducing deflection to a minimum and insuring permanent alignment. **2.** Control of machine function by readily interchangeable programming cam units, for quick job change-over and precision machine operation. **3.** Simplified hydraulic servo control system combining the advantages of both cam- and hydraulically-operated machines for accurate machine control and extremely smooth, responsive operation. **4.** Unit-type design, ideal for use in automated lines. **5.** Extremely rigid, stable construction, guaranteeing continually accurate production.

Investigate what the "Centalign" can do for you. Ask for an immediate demonstration.

BRYANT Chucking Grinder Co.

85 CLINTON STREET, SPRINGFIELD, VERMONT

Offices: Indianapolis • Cleveland • Chicago • Detroit • Mt. Vernon, N. Y. • Philadelphia

Internal Grinders • Internal & External Thread Gages • Granite Surface Plates • Magnetic Drums for Computers • Special Machinery

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The Editor's Page

Thank You!

Appreciation and recognition from the industry on a job well done is always pleasing, whether to a publisher, an editor, a production executive or a worker. Everyone likes to know his work merits approval and he likes to receive this approval.

The staff of GRINDING and FINISHING is no exception to this basic human trait. Frankly, we are pleased to know that the National Safety Council presented G and F with an Award for Exceptional Service to Safety.

No publication, however, should make a noisy parade out of having won any type of industry recognition. It is supposed to serve; its function is to aid, inform and to act as a clearing house for industry problems. If it fulfills its obligations it does no more than justify its existence and if its work should be commented upon or praised, it should pause briefly and say, Thank you, and get on with the next issue. So, to the National Safety Council the staff of G and F says, Thank you for the recognition! We are pleased over your expression of approval and we shall continue our efforts to remind our readers and our industry to follow safe grinding practices at all times.

Discussing safety in the grinding industry has its problems. We do not believe grinding is an unsafe occupation. We do not believe more accidents happen through use of grinding machines and wheels than happen in other phases of metalworking, and we do not want to plant the idea in the minds of readers that our bearing down on safety is because grinding is a dangerous occupation. Any grinding operation, press operation, or any other metalworking operation is as safe as the worker makes it. No more and no less. If the worker is careless, hasty, ignores manufacturers' recommendations, he can wind up reading his newspaper in Braille. Accidents, in grinding, on the highway, in the home, do not happen. . . . they are caused! They can be prevented!

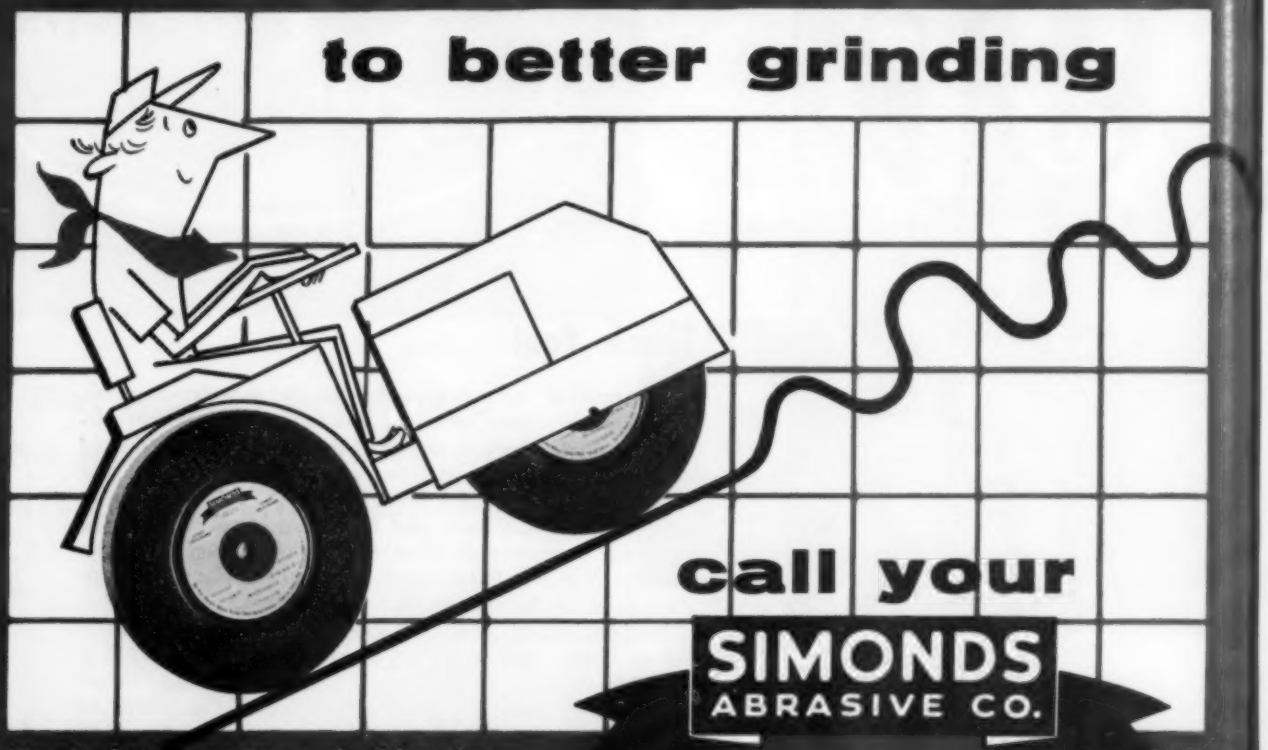
We think one way of preventing accidents is to keep everyone conscious of them; never allowing an operator to forget that he must check wheel speeds, tighten the wheel, use goggles; never allowing the foreman to forget to check his machines and watch his workers for safety violations; never allowing the abrasive engineer to forget that his production quotas and his manufacturing processes must consider safe operating practices. Our work in safety must be in the form of constant reminders for everyone to follow safe practices day in and day out and to constantly heed manufacturers' recommendations.

Wm. J. Schleicher

Editor

Smooth your way

to better grinding



call your

SIMONDS ABRASIVE CO.

DISTRIBUTOR

'Service' to your Simonds Abrasive Company distributor is more than a nice-sounding word. It's a hard-working fact — a basic everyday function expressed in these advantages for you:

Production Know-How

Your distributor knows grinding wheels . . . what they do . . . where they are used . . . and which specification to recommend for grinding on metals, plastics, stone, porcelain, glass etc.

Prompt Delivery

No waiting for distant shipment. No grinding down-time. Your distributor carries local stocks and is within trucking distance of your plant . . . ready to roll at your call.

Emergency Service

When breakdowns or bottlenecks arise, your distributor is ready to come through with the wheels you need . . . or with factory engineering advisory service on your tough problems.

Proven Products

He's backed by Simonds Abrasive Company's complete line of bonded abrasive products, enabling him to supply not only your everyday grinding needs . . . but also your highly specialized ones.

For service geared to your production needs, get acquainted with your Simonds distributor. Let's send you his name. Write.

SIMONDS ABRASIVE COMPANY • PHILADELPHIA 37, PA.

Branch Warehouses: Boston, Detroit, Chicago, Portland, San Francisco. Distributors in Principal Cities

Division of Simonds Saw and Steel Co., Fitchburg, Mass.

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grinding — finishing
AUGUST 1956

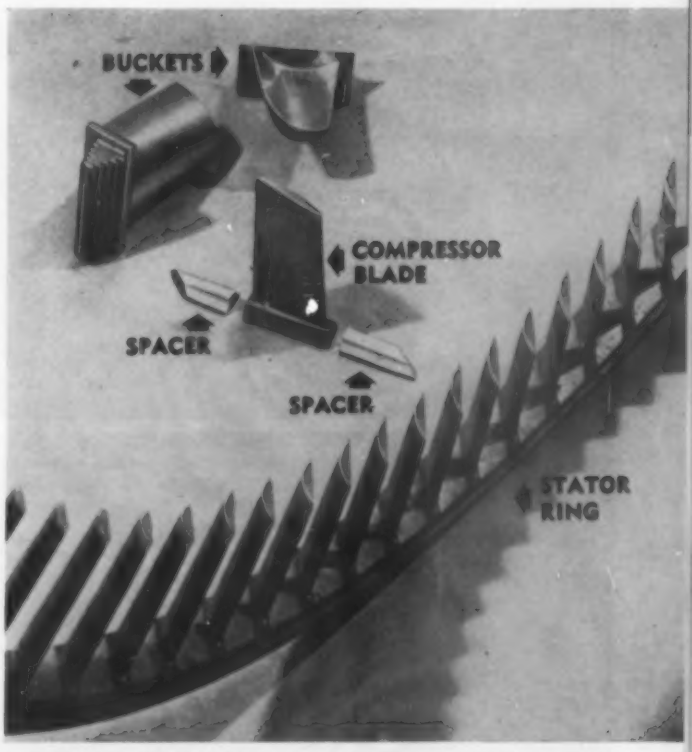
Belt-Grinding Gas Turbine Parts

General Electric's gas turbine department has tailored abrasive belt grinding to meet several complex surfacing requirements of turbine blades and other parts. Resulting savings of $25,000 a year involves specialized, ingenious fixturing.

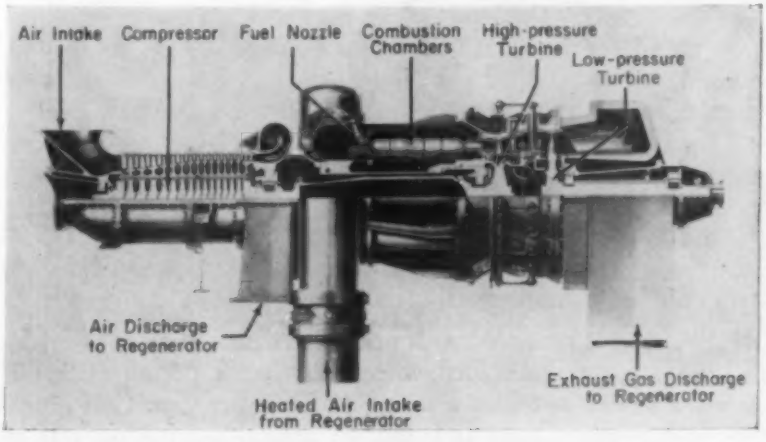
By **Leo F. Byrnes,**
Gas Turbine Department
General Electric Company, Schenectady, N.Y.

● By adapting belt grinders to its specialized requirements through the use of ingenious fixtures, GE's gas turbine department has saved over $25,000 a year on three turbine components: compressor blades, stator rings, and buckets.

Basic machine for grinding each of the parts shown in figure 1 is the Engelberg/Porter Cable Model BG8/FT9 abrasive belt grinder. The Schenectady gas turbine plant uses five of these platen-type ma-



1. TURBINE COMPONENTS are belt-ground at GE's gas turbine plant. Compressor blades, stator blades, and turbine buckets are high-temperature stainless steel.



Cutaway shows basic construction of General Electric two-shaft gas turbine with regenerative cycle. Air from intake, compressed and heated to about 500°F. by axial flow compressor, is fed into combustion chambers, where fuel is added. After the burning fuel—kerosene, distillate, or gas—heats air to desired temperature (approximately 1450 degrees), it is expanded through the turbines. Exhaust gas is brought through a regenerator to preheat compressor air. High pressure turbine wheel drives turbine compressor, second stage turbine wheel drives the load shaft. Typical GE installation is capable of delivering 8000 horsepower for the load, plus about 16,000 horsepower for the compressor.

continued

2. OUTSIDE DIAMETER OF COMPRESSOR BLADES are ground at Engelberg/Porter Cable belt-grinder, using GE-designed oscillating rotary in-feed table. Grinding cycle per wheel, including deburring with tampico brush at left, is twenty minutes.

Features of the G.E. Belt Grinding Set-up for Gas Turbine Parts:

- **Wet belt used on Engelberg machine is 8″ x 107″, 36-grit aluminum oxide. Belt speed: 5000 sfm**
- **Average stock removal from compressor blade tips is .080-inch. Required tolerance of finished blades: plus .000, minus .005-inch ground at rate of 40 per hour**
- **Belt grinding of stator rings saves G.E. about $237 per gas turbine over internal grinding or with boring mill equipped with grinder**

chines—one each for grinding tips of compressor blades, stator blades, and turbine buckets; and two for surfacing compressor blade spacers.

Compressor Blades

Compressor blades are Type AISI 403 steel. Depending on type and stage of gas turbine, compressor wheels have from 34 to 68 blades. Wheels, usually fourteen in number, are bolted together to form axial flow compressor rotor capable of handling approximately 80,000 cu. ft. of air per minute.

Individual compressor blades are secured in dovetail of rotor wheels by spacers, which are inserted on each side of the blade and staked with a hydraulic press punch. The assembly is then mounted on the special machine table of the abrasive belt grinder, figure 2. Outside diameter, blade tip to blade tip, is constant, although compressor wheel diameter and length of blades vary considerably. Since the tie-bolt holes and rabbets are also constant throughout, the wheels are located on the rotary-drive table from the male rabbet, and bolted to the fixture through the tie-bolt holes.

The wheel is rotated at 5 rpm. A cam on the underside of the fixture plate actuates the pump handle of a hydraulic jack, and moves the assembly in against the belt at a rate of 2 miles per revolution, until positive micro-stop is reached. At the same time, an air oscillator device moves revolving blade tips back and forth across the face of the belt to distribute belt wear evenly.

Wet belt used on the Engelberg machine is 8 x 107 inches, 36-grit aluminum oxide, with standard belt speed of 5000 sfpm. Coolant is water soluble oil. Average belt life is fourteen wheels (one complete rotor).

Average stock removal from blade tips is .080-inch (.160-in. on the diameter). Required tolerance of finished blades is plus .000, minus .005-inch. For deburring operation a tampico brush mounted on machine left is fed in manually after wheel is retracted from abrasive belt. Total time required to belt-grind blade tips of one compressor wheel is 20 minutes including loading, grinding, deburring (5 minutes), and unloading.

Compared with prior alternative method of grinding the bladed wheel O.D. on a boring mill, GE has obtained a saving of $7500 per year. Cost reduction figure is based on annual production rate of fifty turbines (700 wheels). Savings on each com-

pressor rotor of fourteen wheels is approximately $150, more than $10 per wheel.

Compressor Blade Spacers

Spacers, staked in compressor wheels on each side of compressor blades, are AISI Type 1020 steel. They require three grinding operations: 1) Squaring the ends which butt against dovetail ends of compressor blades; 2) Grinding the angle on other end to conform with outer width of compressor wheel; 3) Grinding top of spacer to contour of wheel's outside diameter.

A standard Engelberg grinder performs the first two operations, at a rate of 200 per hour for squaring and 150 per hour for angle-surfacing. A second machine for contour grinding is equipped with a pivot arm, which the operator swings back and forth as the hydraulic infeed moves the spacers in against the belt, figure 3. Spacers are contour-ground at rate of 40 per hour.

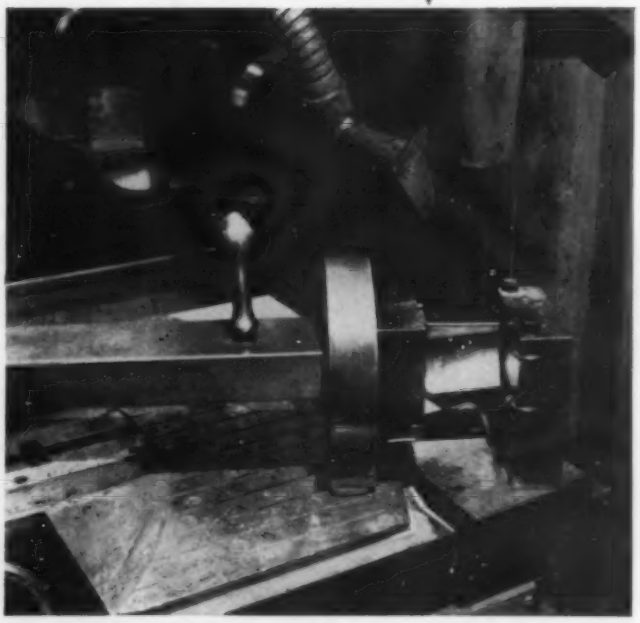
Since outside diameters of compressor wheels vary depending on their position in the rotor, there is a corresponding variation in outer contours of spacers. Consequently, several fixture blocks of different thicknesses are necessary. With the pivot point constant, the operator merely changes fixture blocks on the end of the pivot arm to obtain the desired radius for each lot of spacers. Adjustment

3. COMPRESSOR BLADE SPACERS are squared and angle-surfaced on belt grinder in background. Using same work-holding blocks, spacers are repositioned for contour grinding to compressor wheel O.D. on second machine. Operator sweeps pivot arm back and forth across belt, as machine table automatically moves in to predetermined stop.

4. ENCASING WHEEL FIXTURE, driven at 5 rpm by gear box at left, secures stator rings for grinding inside diameter of blade tips. Machine requires triple-flex belt and curved backing platen of tool steel to conform with I.D. of rings. Diameter is checked by contoured go and no-go surfaces of steel gaging block inside stator ring at right.

5. BUCKET TIPS are surfaced on wet-belt grinder equipped with adjustable pivot arm, at rate of 100 per hour. Blade tip angle is controlled by scissors jack and adjusting blocks beneath machine table. Belts used are 36-grit aluminum oxide, 8 x 107 inches.

6. CLOSEUP OF BUCKET FIXTURE shows pinetree dovetail recess in which buckets are inserted. Two hardened steel discs in left of gaging block form go-gage; those at right, no-go. Tolerances are plus .000, minus .005 inch, with stock removal of .050 to .060 inch.



BELT GRINDING AT G.E.

continued

blocks beneath the machine table compensate for the compound angle of the compressor wheel face.

Spacers are ground to a specified tolerance of plus .000, minus .005-inch. Abrasive belt is same as used on blades, 36-grit wet aluminum oxide. Approximate belt life is: squaring, 1600; angle surfacing, 1200; contour grinding, 500.

The fixture blocks are so designed that spacers can be positioned in them with either the square end, angle end, or outer face presented to the belt. The same set of blocks are used on both machines, and accommodate all three grinding operations.

Stator Rings

Stator rings, used in compressor casing, are made in two semi-circular parts with blades matching those of the compressor rotor—34 to 68 blades in a complete ring. Blades are AISI Type 403 steel.

For belt grinding I.D. of stator rings, an Engelberg machine is encircled by a special rotary work-holding fixture. The two stator segments are centered with rabbets inserted in the grooved fixture wheel. They are firmly anchored by a top fixture ring which is bolted to the under wheel.

The drive box on left of machine meshes with gear teeth on outer perimeter of the wheel fixture, figure 4. Wheel speed is constant at 5 rpm. A cam and hydraulic jack device similar to the one used on the compressor wheels feeds the rings into the belt at a rate of .002-inch per revolution.

Stator blade tips are angled for alignment with compressor wheels, which increase in O.D. from intake to discharge end of rotors. The corresponding grinding angle for the stator rings is obtained by inserting adjustment blocks under the fixture wheel.

A special platen of dense tool steel is convex-curved to conform with the inside diameter of the stator rings. This necessitates use of a triple-flex abrasive belt, which is tensioned at 1000 pounds. Belt is cloth, waterproof, 36-grit aluminum oxide, 8 x 107 inches. Belt life is one complete set of 15 stator rings.

Tolerances are same as those for compressor blades. Stock removal is .050 to .060-inch on the radius, plus .025-inch more on angular tip blades. Grinding time complete is 25 minutes per ring.

This grinding sequence—versus internal grinding, or boring mill specially equipped with grinder—has saved G.E. $11,875 a year, or $237 per gas turbine.

my name is

Ping Ianitelli

in charge of our

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My division will actually machine parts for you. Not just a single sample, but enough production runs to provide a true evaluation of what Elox Electrical Discharge Machine tools can do in your plant. Tungsten Carbide tipped single point tools, forging dies, die casting dies and Tungsten Carbide form tools will be machined at a cost we guarantee impossible to duplicate except with Elox E.D.M. I've been able to prove to hundreds of alert concerns that these jobs can be done better, faster and less expensively with Elox than by any other method.

WE SAVED 19 MINUTES

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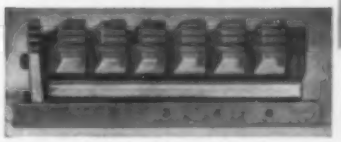
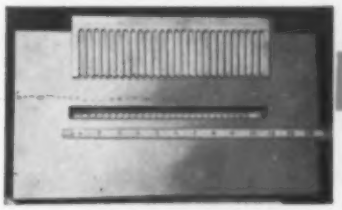


WE SAVED 16 HOURS

plus 9 different operations on this form grinding of a carbide broach.



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"We find Norton discs outproduced others 2 to 1"

One of many job reports showing how Norton discs add the profit-boosting "TOUCH of GOLD"

MORE OF THE SAME:

- "Norton discs the best ever received. Produced over 6,000,000 piston rings — 100% more than our former discs, with 50% less dressing. Results duplicated in subsequent shipments."
- "Outlasted and outperformed all other discs. Gave 366,975 pieces without burn."
- "Averaged 21,500 pieces, a new high for this job."
- "High above competition for output and grinding quality."
- "Gave 20% longer service life."

What Norton discs have done for others, they can do for you.

That goes for any material you're grinding, on any type of disc grinding machine.

LAPPING ENDS OF TRANSFORMER COILS on a Norton 60-F HYPRO-LAP* lapping machine equipped with a Norton disc. Only Norton offers you such long experience in both grinding wheels and grinding machines to help you produce more at lower cost.

Norton discs of ALUNDUM* and CRYSTOLON* abrasives are made in all standard grit sizes, all grinding grades, five types of bonds and all types of mountings. They are precision-built for closest uniformity — so you can depend on the same cool cutting action and extra long service life every time you re-order.

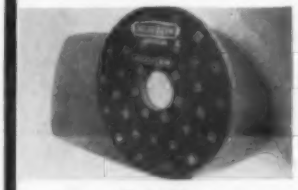
See Your Norton Distributor

for valuable aid in selecting the right discs for your jobs. Ask him for the booklet, *Disc Grinding*. Or write to the nearest district office of NORTON COMPANY, Worcester 6, Mass. Distributors in all industrial areas, listed under "Grinding Wheels" in your phone book, yellow pages. Behr-Manning Company, Troy, N. Y., division of Norton Company. *Export:* Norton Behr-Manning Overseas Incorporated, Worcester 6, Mass.

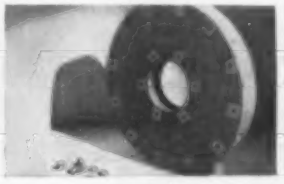
W-1723

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

For Every Job — Norton discs are made in all types of mountings, six of which are shown here.

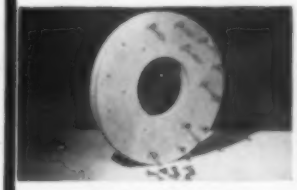


Resinoid (Inserted Nut)



Vitrified (Inserted Nut)

Silicate (Inserted Nut)



Solid Plate Mounted (Projecting Stud Type)

Solid Plate Mounted (Loose Screw Type)

Segmental Plate Mounted

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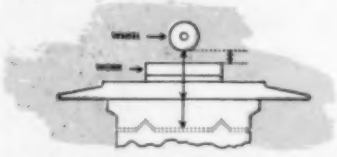
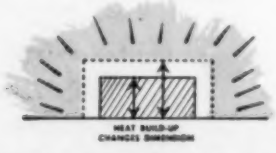
DoALL Takes the Guesswork out of Surface Grinding

The DoALL Maintains Wheel Diameter. The leading edge of the wheel takes the brunt of the cutting. The edge wears but the wheel face and diameter remain intact, assuring accurate stock removal. This is achieved by machine rigidity, smooth table travel and cross feed occurrence before the wheel contacts the workpiece.



The DoALL Maintains Table-to-Wheel Distance Under Load. Absence of spindle and saddle deflection plus a constant thickness oil film on all hand scraped ways assures parallel work travel under the wheel.



The DoALL Minimizes Thermal Expansion. DoALL "Cool-Grinding"* (coolant through the wheel) plus flood cooling controls workpiece temperature, minimizing expansion which produces undersize dimensions when work cools. Cool-Grinding helps to keep wheel cutting free, permits heavier downfeeds without burning or checking the workpiece and reduces the frequency of wheel dressing because diameters are maintained for longer grinding periods.

You get more output per hour because you don't have to stop to check dimensions . . .

The amount of work produced on a surface grinder depends on whether its feed calibrations represent an equivalent amount of stock removal. To grind, measure and then grind some more to secure final dimension is a costly waste of time.

DoALL takes the guesswork out of surface grinding because the wheel removes stock exactly according to downfeed setting. This reliability does not exist in all surface grinders. An accurate handwheel alone does not make an accurate surface grinder. Nor can accuracy be determined except under the stress of grinding, as illustrated at the left.

For true precision grinding with greatest output per hour, there is nothing to match a DoALL.

ASK FOR A FREE DEMONSTRATION — Compare a DoALL with any surface grinder in your shop. See it in operation on a DoALL demonstration wagon right in your own plant. Call your local DoALL Store or write:

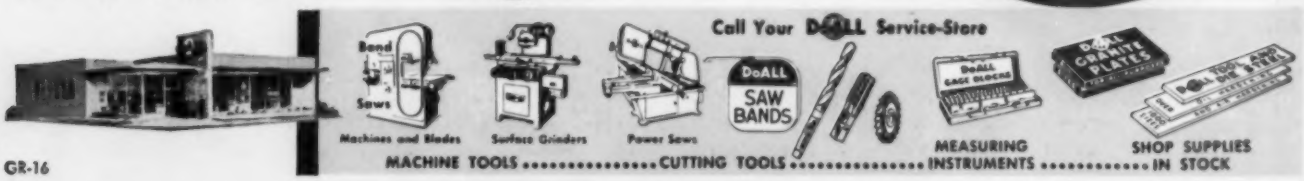
The DoALL Company,
Des Plaines, Illinois

Ask for Grinder Catalog

*U. S. Pat. No. 2470350

38 local DoALL Service Stores offer free demonstrations.

DoALL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GR-16

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Buckets

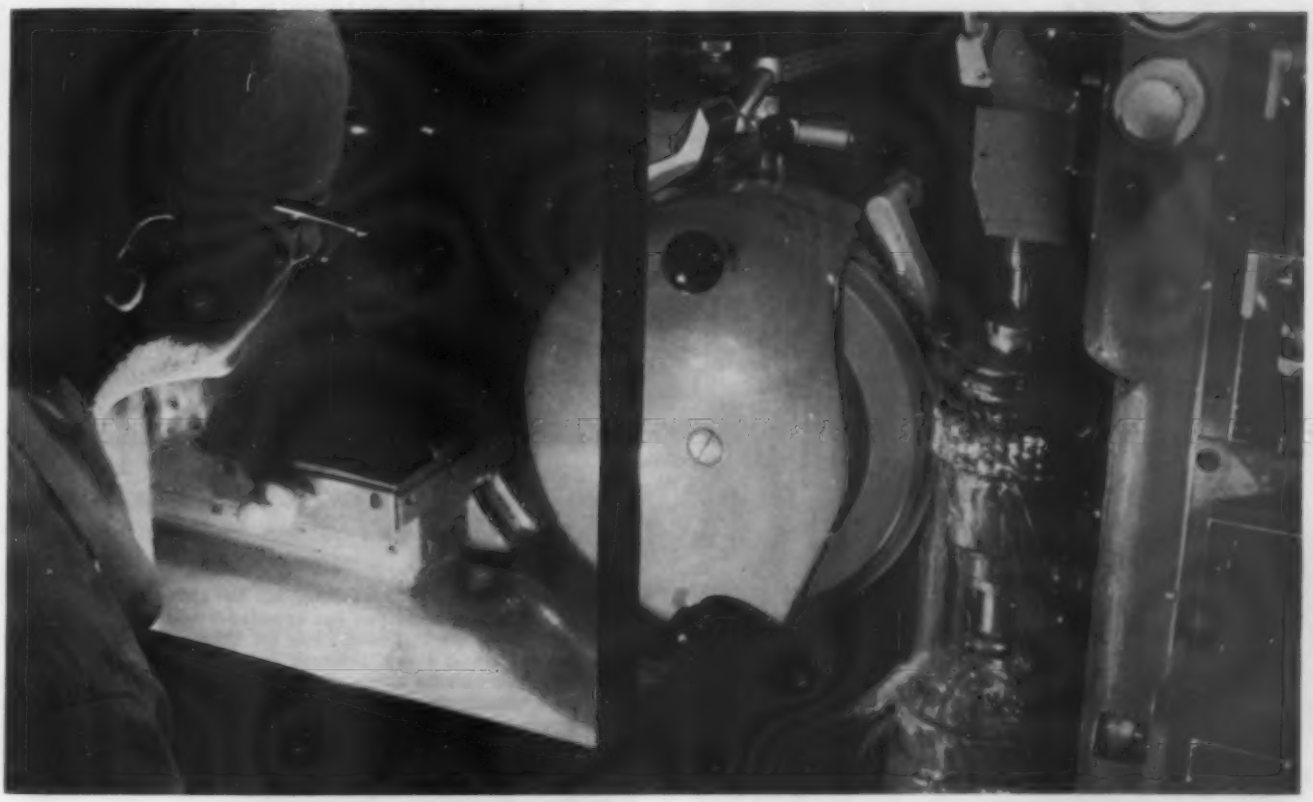
The buckets used in turbine rotors are subjected to the highest stresses of any part of the machine. Materials are high-temperature alloys. Ninety-six buckets are used in each wheel of a two-stage turbine rotor. Buckets have pinetree dovetail, figure 1, for mounting in rotor wheels.

For belt grinding tips of buckets, G.E. uses a pivot bar setup similar to the one used for contour grinding compressor blade spacers. The pivot arm is adjustable to give the required radius. Buckets are inserted in the female pinetree dovetail of the work-holding block, figure 6. A scissors jack and spacer blocks tilt the fixtured table to the proper blade tip angle.

Wet belt used is 36-grit aluminum oxide and coolant is water soluble, as in the other operation described above. Belts are changed for each set of 96 buckets. Bucket tips are finished at a rate of 100 per hour, loading, grinding, and unloading. Stock removal is .050 to .060 inches, with standard tolerance of plus .000, minus .005-inch.

Unit grinding costs are only 3 cents per bucket. Formerly, buckets were assembled on the rotor wheel, and O.D. of blade tips was ground on a boring mill. Belt-grinding eliminated additional handling of two-ton wheels, and saved G.E. $7890—$78 per wheel—on annual production of 100 rotor wheels. • • •

Grinding Precision Gears . . . . . Faster



One of three new worm grinding wheel type gear grinding machines in operation at the Warner & Swasey plant.

CLEVELAND - Because of the necessity of maintaining extreme accuracy and high production, The Warner & Swasey Co. of Cleveland was faced with a serious bottleneck in its precision gear grinding operations. In an attempt to eliminate the problem, three new worm grinding wheel type gear grinding machines have been installed.

These new grinders have proven so successful, the company has ordered another machine capable of handling gears up to 28" diameter. In addition to reducing grinding time to a minimum, they have consistently held close tolerances.

Using the new equipment for both spur and helical gearing, Warner & Swasey reports it now is able to grind precision gears in 1/3 the time formerly required on conventional grinders. Accuracy is held to .0004". Success has also been attained in the single operation grinding of tricky spiral gears and long addendum gears for turret lathes. It was necessary to split the grinding of these difficult parts into several separate operations.

Other important advantages gained from use of the new gear grinders, which are comparable in price to other grinding equipment, include considerably less maintenance expense, fewer wear points to contend with, and greater handling ease for the machine operator. An average worm grinding wheel for one of the machines lasts approximately two years in normal service; the wheel being dressed daily. • •

Can Small Plant Grinding Operations Be Automated?

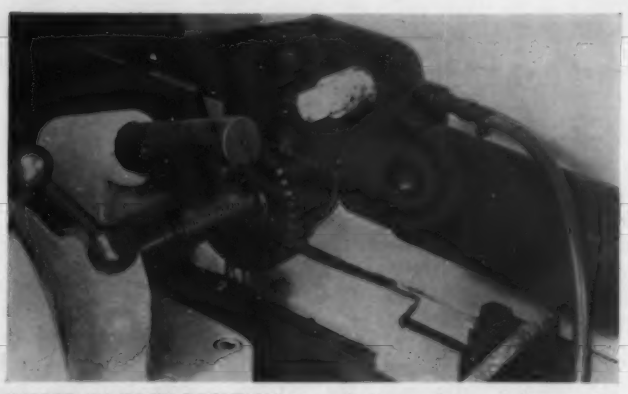
Here's a 23-employee shop that has automated to the hilt. How? . . .

- By equipping its grinders with homemade automatic feed attachments and work drivers; modifying some machines for repetitive special operations.
- By emphasis on flexible setups, reduction of non-productive time with automatic cycling; reducing skill requirements for machine operation.

By **Jack Kenyon**
Associate Editor

TWENTIETH CENTURY'S AUTOMATIC INFEED ATTACHMENT on No. 2 centerless has speeded production on infeed centerless work. Control box on front of machine houses electronic timer, solenoid valves for pneumatic cycling, and bleeder valve for control of feed rate. Controls are grouped adjacent to work position; operator starts each grind with start button.

PNEUMATICALLY-ACTUATED RACK is against positive stop (notched bar in extreme upper left) in sparkout timing position on completion of infeed.



INFEED IN OPEN POSITION at end of complete grinding cycle. Notches in positive stop aid in approximating stock removal adjustment during setups; unit gives stock removal range from 5 to 40 thousandths, with accuracy of .0001 inch.

• Significant among findings of the recent 1000-plant ASTE Automation Survey is the fact that 15 per cent of grinding and finishing operations in plants of all sizes can be automated. Even more significant perhaps than the overall 15% figure is the estimated ten per cent of small-plant (under 250 employees) grinding and finishing operations that can potentially use automation.

Does automation for the small shop pay? Can it be made flexible enough to take care of frequent part changeovers?

The experience of one small plant, Twentieth Century Manufacturing Company, gives an emphatic "yes" to both questions. Twentieth Century is a 23-employee, 14,000 square-foot plant manufacturing reamers in Libertyville, Illinois.

"We began business when other companies in the tool field were going bankrupt," explains W. L. Garberding, Twentieth Century president. He figured the only way for him to survive was by going heavily into automation.

The capital position of the young firm, however, was such that special machines for Garberding's requirements in reamer manufacturing were out of the question. It was up to him to develop the needed automatic devices and adapt standard machines to his purposes.

As a result, Twentieth Century has some of the most ingenious tooling and automation equipment we've seen anywhere, and all of it has to be flexible to accommodate the part variations encountered in normal production. Emphasis has been placed on cutting non-productive time on all machines, reducing skill requirements of operators wherever possible (Twentieth Century has felt the skilled-operator shortage just like every other shop these days) and on eliminating manual control of work cycles. The result all along the line has been higher production rates and resulting lower costs.

Automatic Infeed Attachment

Among the interesting automation equipment built by Garberding is an automatic infeed grinding attachment which controls the infeed cycle of a Cincinnati No. 2 centerless grinder. Timing for the infeed cycle is electronic, and actuation of the regulating wheelslide is pneumatic. With a cost around one-twentieth as much as a grinder, Garberding figures the unit has paid for itself in only a few months.

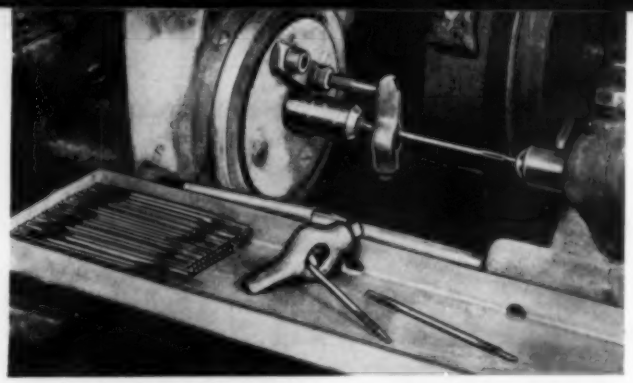
The part being run on the machine when we visited the plant was a small-diameter pilot reamer, being brought to finish size with stock removal of .003 to .005-inch, and being held to limits of .0001-inch, typical of runs in Twentieth Century production.

Range of stock removal available with the unit is from .005 to .040-in. in one pass, and is varied by adjusting a simple variable-position mechanical stop which limits travel of a rack driving the lead screw nut.

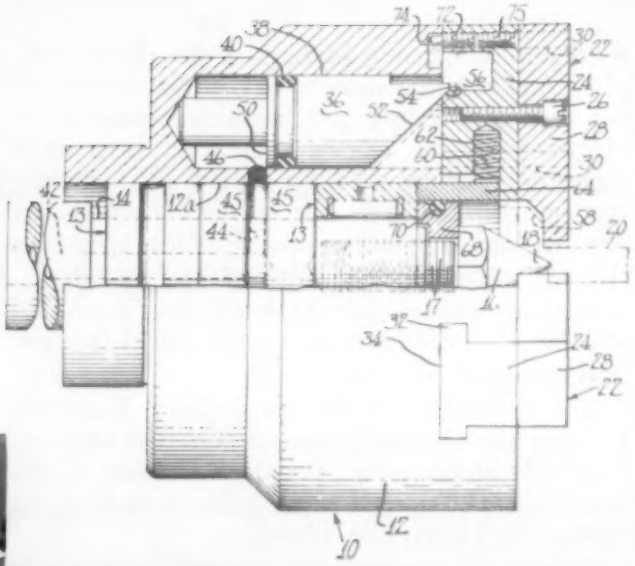
In operation, the operator drops the workpiece between the wheels and presses the stop button on the panel mounted near the work position. This actuates the timer, which has an automatic voltage regulator to maintain constant cycle time, controlling operation of the pneumatic cylinder. The cylinder drives the lead screw rack through the infeed stroke at a speed regulated by adjusting a bleeder valve in the air line. Stroke of the rack is then limited by the positive stop. At this point a sparkout dwell is provided for by the timer, which maintains air pressure momentarily to keep the rack against the stop. The length of dwell can be varied as required.

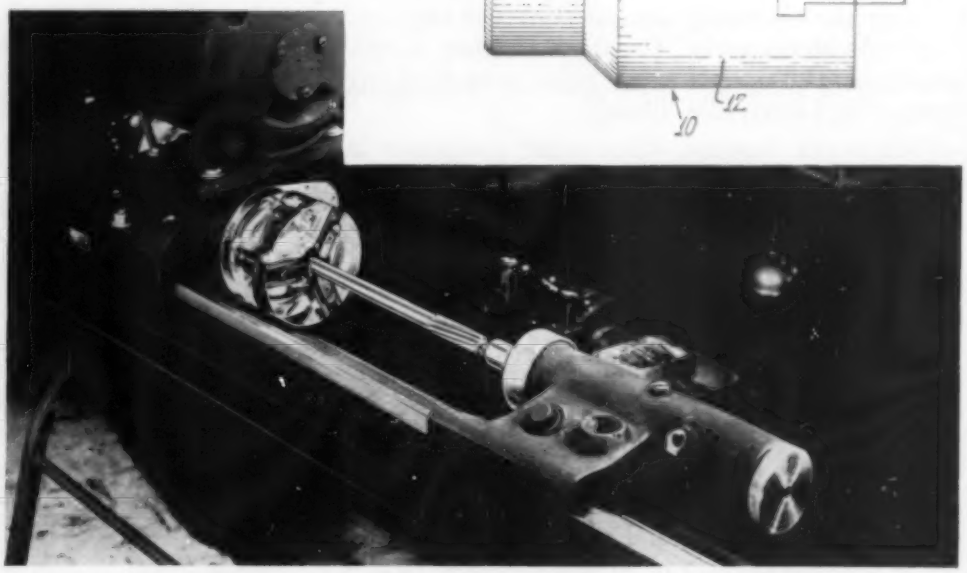
Total infeed stroke can be kept as low as .007-inch, a feature built into the unit because much of Twentieth Century's work is on small diameters and involves light stock removal. With such a small wheel slide travel, small workpieces can't get wedged between the regulating wheel and the workrest blade, which is a decided safety advantage. Garberding has found that setup time for the grinder has been reduced appreciably by the unit. As a safety feature, a red caution light goes on during setups, and it also glows during the grinding cycle to caution the operator against insertion of another workpiece. Among other benefits, it has been possible to increase the number of grinds per dress, possibly because feed motion is more uniform than with hand opera-

TWIN-TABLE MODIFICATION of surface grinder allows use of permanent setups for grinding 45° chamfer angle and 90° face on reamer tips.



FORMER DOGGING METHOD was wasting 30% of operator's time in OD work on reamers, was marring work with dog set-screws.





NEW CHUCK has upped production to point where one operator can now run two machines. Sectional view of compensating chuck from patent drawings shows how pressure is introduced through bore in dead center, distributed to axial cylinders to actuate piston with beveled jaw for closing jaw. Spring return is used on jaw for automatic loading applications.

tion. Surface finish on the workpiece has also improved.

Automatic Compensating Chuck

Out of the realization that 30 per cent of an operator's time was being wasted in dogging reamers for flute sharpening and for general OD grinding between centers, Twentieth Century developed a small hydraulically or pneumatically-actuated compensating chuck. The chuck is being used extensively in grinding operations in their shop and has attracted so much attention that, as is often the case with developments of its kind, plans are being completed for marketing them as a sideline.

The chuck head rotates about a dead center, cone cup, or other locating nest and is self-compensating, each jaw operating independently of the others. Concentricity problems are eliminated by the simple chucking principle used, since the work is driven between two dead centers by the self-adjusting jaws. The chuck has been designed with a range of 3/32-in. to 27/32-in. for applications in the shop, using only one set of interchangeable jaws for the whole range. Use of the chucks has saved Twentieth Century $5000 a year per machine, and enabled one operator to run two machines at a time.

Demonstrated for us by Mr. Garberding, the chuck was shown to be able to compensate for work with centers off the centerline ⅜-inch, or eccentric as much as ¾ inch.

The patent drawing of the chuck, depicted on this page, shows the very simple principle on which it operates. Air or hydraulic pressure is introduced through the dead center to an annular groove which distributes it to each of three axial pistons. The pistons in turn drive the chuck jaws individually against the workpiece by a wedging action. As the first jaw contacts the workpiece, in case of eccentricity in the piece, it stops on contact without exerting any force until all three jaws are in position. With 500 psi hydraulic pressure on the line, clamping force exerted by the jaws is 350 pounds, more than adequate to drive any work in the Twentieth Century shop.

Automatic cycling of the chuck can be provided for by means of solenoid control valves in the line, together with spring retraction of the jaws. This will make possible use of the chuck in conjunction with automatic loading devices.

The carbide-tipped dead center is removable for resharpening, and the "O" ring seals on shaft and pistons are the only wear parts needing replacement. Chuck jaws don't need adjustment or regrinding for runout. • • •

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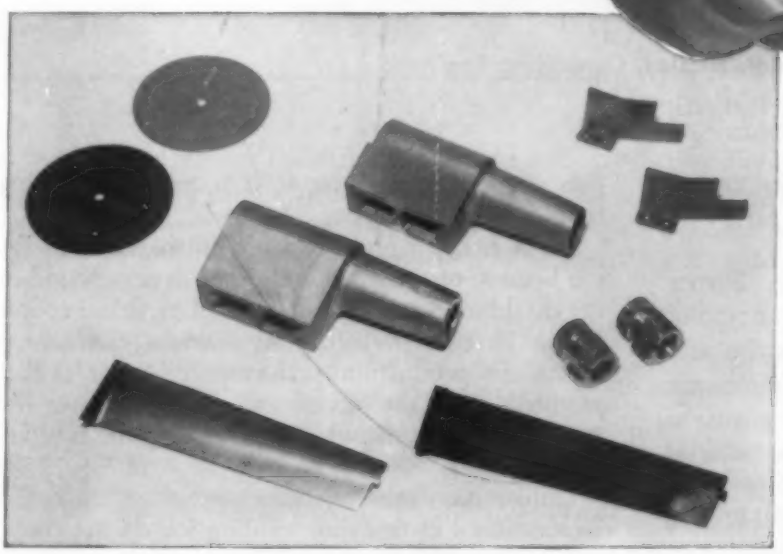

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What Constitutes a Fair Day's Work?

The union insisted the job had an unreasonable work standard. The company maintained that its five time studies plus other duties signified their good faith. Here's how the arbiter ruled.

By **Harold R. Nissley,** Consulting Engineer
Cleveland Heights, Ohio

ISSUE: What constitutes a fair day's work on Operation 8—Spot Weld 26 Body Wires to 5 Rings?

GRIEVANCE STATEMENT: "Rubbish Burner Rate: Operators feel rate is unfair for (this) type of job and wish another time study with union and management (present). There is too much difference in rate between this and similar jobs. They wish to have this settled one way or another, as soon as possible."

s/E. Johnson, April 7, 1956

Background and Facts

The A.B.C. Products Company is a typical job shop. It makes a wide variety of items—mostly out of wire. Like other job shops, frequent changes in work assignments are common.

But a few jobs, like the rubbish burner, are long-run jobs. This is a standard item with the company and has been made for years under patents which expired a few years ago. Because it is a standard item, operators working on it have a chance of "getting in the groove" production wise.

The job in dispute is a spot welding job. Briefly, the operator picks up and positions 5 wire basket rings into a special spot welder. In pairs, he next picks up 26 side wires and spot welds these onto the five rings. The end result is a partially finished rubbish or paper burner.

There is not a great deal of skill required in this job because of the stops and other devices found on the machine. But a good amount of eye-hand coordination is required before an operator can achieve maximum production performance. Some skill is required to make occasional adjustments in the welding electrodes whenever off-size rings come through.

Unlike many other machine operations, the special welders used in this spot welding job do not constitute a limiting factor in operator production or earnings. The welding cycle time constitutes less than 12 per cent of the total work cycle; so even considerable differences in machine welding time would affect the operator's output minutely.

Union's Position

The Union's position is set forth in the grievance statement above. The Union feels that these welding operators must put forth a tremendous amount of effort for a modest amount of income. The Union, therefore, wants relief from what it considers an unreasonable work standard.

Company's Position

The Company feels that its five time studies on two operators plus two eight-hour studies is proof

Handling people and working with unions is an important part of today's production management. For this reason the editors feel that grinding and finishing executives might be interested in this case. While this case does not deal specifically with grinding operations the basic problem faced might well be duplicated in any grinding department. Names and other identifying characteristics have been changed or withheld. Because no two cases are identical, the reader is cautioned to read this case in the light of a particular set of circumstances.

of its desire to go the full length in arriving at an understanding of what constitutes a fair day's work on this job. These many studies on different operators and by different observers yielded results that were within 90% of one another.

The Company points out further that it offered to re-establish a low standard of 40.3 units per hour (the lowest standard developed during the foregoing studies). Despite the silent acquiescence to this standard (April 8, 1955), the Union continued its demands subsequent to the meeting.

Discussion (By Arbiter)

The parties imposed very few limitations upon the Arbiter in arriving at his conclusions. But they did not wish him to probe into the earnings of these or other operators in the plant. The Arbiter will, therefore, confine his remarks to the issue, "What constitutes a fair day's work on this spot welding job?"

Whenever the subject of a fair day's work comes up, there invariably arises the question of rating. And because the Union constantly stressed the point that they felt the Company was "too tight" in its rating, the Arbiter gave this phase of his investigation considerable attention in the following manner:

1. In a preliminary talk with each operator I admonished him: "To give me a good production performance—neither fast nor slow; to work at a pace that he could maintain over an 8 hour period."
2. I checked my own rating with the rating which I gave other operators on the same job. Fortunately, there were many operators to choose from.
3. I checked, of course, the speed of these operators with the speed of male and female operators whom I have observed in scores of factories in the last two decades.
4. I asked both Company and Union representatives present during all or part of these time study observations whether they thought I had obtained a fair work sample. I suggested that if there was any doubt in anyone's mind about this point, I would continue making production floor time studies. Everyone agreed that I had a good work sample from which to work up my job standard.
5. To minimize the cumulative effect of fatigue, studies were made at the beginning, at the end, and during the middle of shift operation.
6. Elemental as well as over-all ratings were used in judging operator performance. Consistency was tested throughout these studies by running sample checks. Only when successive samples came within 90% of previous data did observations cease.
7. Further test of adequacy of sample is attested by the following data: A 75 minute study was made on Operator Smith (involving 72 cycles or burners); a similar sample was taken on Operator Dawes; 72 cycles was also observed on Operator Johnson.

All of these operators are to be commended for giving good work performance under conditions which might affect their wages.

Notwithstanding the extreme care that was exercised by the Arbiter in arriving at his final production rate of 54.1 units an hour, other variables in the current situation make it prudent to surround this standard with a tolerance limit of plus or minus 8%. Thus additional work by the Arbiter on this job could yield a standard as low as 50 units per hour or as high as 58 units per hour.

What are these other variables? One is the allowances. The Company, for example, allows a flat 5% for unavoidable delays—minor machine breakdowns (less than 1/10 of an hour), etc. The Union raised a question as to the adequacy of this 5%. Proof of the adequacy of this allowance would have to await long and tedious 8 hour studies. From what the Arbiter saw during his four hours of observations, it would seem that 5% is adequate; for there were very few interruptions of even one minute.

Because the present job design compels the operator to stand while performing his work, the Arbiter

allowed 5% for fatigue in addition to the 5% allowed for personal needs. But younger and more carefully selected operators may not need this 5% fatigue allowance; they might work straight through the day without taking out much time for rest and recuperation.

Although the Company did not allow any time for preparation and cleaning up, the Arbiter did incorporate a 1% allowance for these two items—2½ minutes at the beginning and 2½ minutes at the end of the shift. This 1% allowance might be included in the Company's 5% unavoidable delay allowance. Evidence was lacking to support any definite conclusion on this point.

The total allowances used by the Arbiter amounted to 16%. The total allowed by the Company was 15%.

Notwithstanding these many variables—including a different system of rating—the final work standard of the Arbiter and a comparable one used by the Company are within 97 per cent of agreement.

But the Arbiter is puzzled over the discrepancies between the past performance figures of these operators and their demonstrated performance during his four hours of observations. Operator Smith, for example, was producing at a rate 24% greater than his previous average; Operator Dawes produced at a 34% higher rate than his previous average; Operator Johnson produced at a 27% higher rate than his previous average. When the 16% allowance figure is applied for 8 hour performance, these operators could improve their earnings situation by 5% to 10%—not by working any harder than they demonstrated to the Arbiter but by working more consistently over the 8 hour shift. Surely this 5% to 10% premium over and above what these men are now taking home should help to overcome much of the job frustration that has developed during the past several months.

Award

Because of the demonstrated performance of the grievant operators; because of the Arbiter's 100% (high task) rating of these operators; because of Company and Union agreement that these operators were representative operators; because of Company and Union agreement that the Arbiter's production floor observations represented fair work samples; for these and other reasons brought out in Tables 1 and 2 and elsewhere in this report, the Arbiter must conclude that 54.1 burners per hour (high task) represents a fair day's work on Operation 8 for the HW-1200 Rubbish Burner. Converted into Company low-task work units, the standard for this job becomes 41.6 units per hour. • • •

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GRINDING safely

By **Edmund Mottershead,** President
Mottershead Associates
Chicago, Ill.

● During recent years, a number of small high speed grinding machines have been introduced for use with mounted wheels and points. These run at various speeds, some of them being rated as high as 100,000 r.p.m. This makes it possible to operate even the smallest diameter points as really efficient surface speeds.

WRONG . . .

OPERATOR CHECKS ENDPLAY in shaft and mounting of small wheel used for grinding welds and steel castings. Position of left thumb is such as to impede quick release of wheel should it be accidentally turned on while he is testing it. Right hand holding throttle from air line is in unsafe position, might accidentally turn grinder on, burning his other hand.

Proper recognition of the "critical speed" is the most important factor in the safe operation of mounted points and mounted wheels. Operation at the critical speed is very apt to result in spindle failure, either through severe bending or fracture.

Every spindle with a wheel or point mounted on it has a certain critical speed at which vibration due to deflection or whip tends to become excessive. This critical speed varies with the dimensions of the wheel, the spindle diameter, and the distance from the support to the base of the wheel. Thus we find that:

1. Increasing the size of the wheel, either diameter or thickness, will lower the critical speed and lower the safe operating speed.
2. Increasing the diameter of the spindle will raise the critical speed and thus raise safe operating speed.
3. Increasing the overhang, the distance from the end of the support to the base of the wheel, will lower the critical and safe operating speeds.

Operation at or near the critical speed must be avoided. It is recommended that wheels be operated at a speed not higher than 75% of the critical speed.

The safe operating speed for mounted wheels and points with threaded spindles is in the range from 50% to 60% of indicated critical speeds.

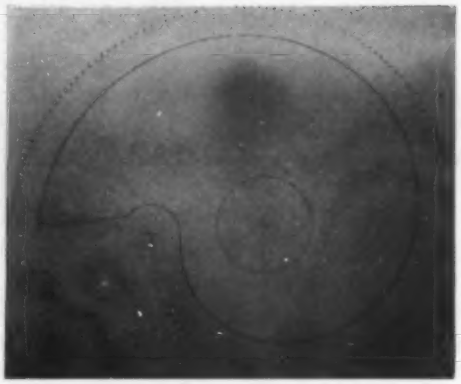
RIGHT . . .

SAFE WAY TO ACCOMPLISH WHEEL CHECKING involves only slight shift of left hand position to facilitate quick release plus insertion of fingers under throttle handle instead of on top of it as shown. This prevents accidental turn-on and possible injury to operator.

EASY DOES IT . . .

HIGH SPEED POINT IS APPLIED TO WORK with a light touch AFTER operator has demonstrated to his own satisfaction that the grinder and points are in good operating condition.

1. CAM TO BE DUPLICATED by dia-form ground dies.



2. "PERSPEX" LAYOUT of cam contour

FORMER METHOD: 4 days to make tool to produce this cam

DIA-FORM METHOD: 3 days to make template; punch and die replacements in 4 hours

SCOTLAND'S BURROUGHS ADDING MACHINE CO. SCORES TOOLROOM PRODUCTION GAINS USING . . .

Dia-form Grinding of Blanking

ADVANTAGES OF THE DIA-FORM METHOD:

- Accuracy—guaranteed less than .0005" error in punch or die.
- Consistency of profile—no matter how many sections or whole tool replacements.
- Errors due to distortion or other heat-created stresses eliminated, since steel is hardened and tempered before grinding.
- Replacement sections can be produced as exact replicas of the original.
- Whole punch and die replacement time reduced from four days to four hours.

● Ninety-five per cent of the precision blanking dies and punches now being built by the Burroughs Adding Machine Company at the Strathleven, Scotland factory are being ground by the dia-form method. Tools made in this way—and these include many with close profiles and difficult outlines held to extremely close tolerances—are involved in the production of more than 2½ million component parts for Burroughs business machines each year. The remaining five per cent are tools which have sharp corners inside a profile and close together. As the chisel point diamond contour dresser supplied to Burroughs has a .005 inch radius, Burroughs is limited to that extent in the application of their present tooling program.

Briefly, the dia-form method involves the precision profile-dressing of grinding wheels to the exact contour necessary on the finished punch or die. This is done by a high-precision tracer device which duplicates the motion of a stylus following an oversize master template of the part to be duplicated, transmitting the motion to the blade-type diamond wheel dresser.

Not only has toolmaking gained in accuracy, but

3. WHEEL-FORMING OPERATION. Using stylus, operator traces master at left; diamond blade dresses wheel at right.

Dies and Punches

the production time of the initial dies and punches has been reduced and economies effected in the cost of making replacements.

Comparison of 2 Methods

A comparison between working times illustrates the gains. Formerly four days were needed to make the tool for producing the small cam illustrated in figure 1. By the dia-form method, a complete tool can be produced initially in three days, and subsequent whole tool replacements can be made in four hours. The three days are taken up in making the template. This has been compared with the work normally done by a toolmaker to produce the actual tool, and comparison can only be done on the first tool to be dia-form ground, since another complete tool could be made in four hours, which represents the grinding time required.

In the former method, the tools were made from a basic blueprint. The toolmaker began by cutting and filing a soft piece of steel. Once the die and punch were made to size, the steel had to be hardened. But there were certain problems here due to distortion and other effects of heat. The new method scores heavily in the replacement of sections or complete tools. It is only necessary to re-set the wheel up on the grinder and follow the template to cut the section of die or punch from a piece of hardened steel.

Making the Template

The first stage in the production of a tool by the dia-form method at Burroughs is the making of a "Perspex" layout, ten times the size of the part to be reproduced. See figure 2. From it a template is made from 3/32" flat steel stock. In the case of the cam illustrated here, the template was jig bored and jig ground to an accuracy of plus or minus two ten-thousandths of an inch on any of the 120 given points.

Thus the error reproduced on the tool is 1/10 of two ten-thousandths of an inch.

The advantage of producing a template is that, unlike the tool, it can be machine-filed or built up until it is within the required tolerances, these of course being ten times the error produced in the tool.

In some cases templates are checked against the original layout using optical projection equipment.

4. DIA-FORMED WHEELS ready to grind cam contour in die.

5. COMPLETED DIE AND SAMPLE PARTS. Punch, also made by die-form method, not shown.

In the case of the cam in our example, the template was too large to be checked this way, so it was set up immediately on the wheel-profiling machine.

Grinding wheels were set up in the machine, and the operator, following the template with the stylus arm, actuated the diamond which dressed the wheels —a short operation taking only 15 minutes. See figures 3 and 4.

As a check on the accuracy of the master template, a sample piece of steel was then ground with the dressed wheels and checked with the original layout on the optical projection machine. On passing the rigid inspection to which it was subjected, a tool was commenced. This die and punch were already hardened and tempered before being ground.

The first few cams produced by the die are then checked on the optical projector against the Perspex layout.

In this instance the grinding wheels, after use, are left on their mountings so that the minimum amount of time is spent on resetting when sections or whole tool replacements require to be dia-form ground.

The master template is then stored where it will be readily available. Replacement of sections or whole tools can be reproduced quickly as they are needed—an important consideration for a tool which must produce 100,000 cams a year, as this one does.

• • •

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Finish Measuring Techniques

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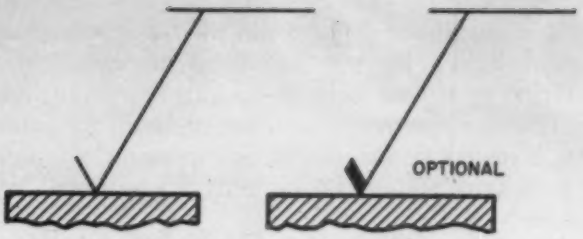
- Keeping drafting standards up to date on surface finish specs
- Methods available to control surface quality



As shown in Section 3–3 of the standard, the following symbols are used with the check-mark symbol to designate the lay of the surface pattern:

= "Parallel to the boundary line of the nominal surface indicated by the symbol.

⊥ "Perpendicular to the boundary line of the nominal surface indicated by the symbol.

X "Angular in both directions to the boundary line of the nominal surface indicated by the symbol.

M "Multi-directional.

C "Approximately circular relative to the center of the nominal surface indicated by the symbol.

R "Approximately radial relative to the center of the nominal surface indicated by the symbol."

1. SYMBOLS indicating surface and lay of surface pattern.

By **E. W. Bolles**
Micrometrical Manufacturing Co.
Ann Arbor, Michigan

● Twenty years ago a brilliant young physicist by the name of Ernest J. Abbott introduced the Profilometer to the metal working industry. His invention was prompted by the need for a simple but accurate method for measuring surface irregularities produced by machining, grinding and finishing operations. The profilometer was engineered with the thought of providing a rugged dependable instrument which could be used on the production line as well as in the laboratory. It received immediate recognition from production people in large and small plants everywhere.

Several years later, other instruments for the measurement of surface finish were made available to the metal working industry. Among these are the Brush Surfindicator, the Talysurf and the Phillips measuring apparatus.

Through the pioneering influence of Dr. Abbott, a basic educational program was established. This program has been expanded many times and is still being carried on through technical societies, universities and classes sponsored by industry.

Before the invention of the profilometer, the eye and the fingernail were the principal methods used to determine the acceptability of surfaces. The common practice of running a fingernail over surfaces and comparing the "feel" was used by shop men to back up their visual judgment of surface roughness. These methods were highly unsatisfactory as they did not indicate either the range of roughness along the surface or point-to-point variations in roughness which are important to production control. The control of surface irregularities provides many cost saving possibilities for the production department and permits higher and more consistent quality of product.

Vocabulary and Definite Specifications

In order to control surface characteristics, it is necessary to identify and measure them. Effective control requires that these measurements be made on a numerical basis, and by an impartial instrument not subject to human error. It has been necessary, therefore, to work out a vocabulary and to establish definite specifications for the measurement of surface finish.

A few years ago the American Standards Association, seeing the need for a set of rules governing the measurement and control of surface characteristics, appointed a group of men, qualified because of their positions in industry, to serve as a committee for the establishing of definitions and specifications.

This group was known as the B46.1 Committee of the American Standards Association. Their final work is known as the ASA Standard B46.1-1955 on surface roughness, waviness and lay.

Table 1 defines the 10 words most commonly used in a discussion of surface roughness measurement and control. The ability to use these words correctly is essential to a working knowledge of instrumentation for the measurement of surface finish.

Our field representatives are frequently asked to speak before technical groups composed of top management, inspection, production and quality control people. Over the years they have found a question and answer period to be a very stimulating and informative part of their presentation. These informal discussions have led to the organization of material into a simple and effective pattern and have pointed to the need for a continuous educational program.

In Figures 1 & 2, you will notice the surface symbol which is universally used to denote the measurement of roughness. The other symbols shown are used to indicate the lay of the surface pattern.

A question frequently asked concerns the difference between the RMS and arithmetical average values in determining surface roughness. Numerically speaking, the RMS average is approximately 10% higher than the arithmetical. The method used in arriving at this number is graphically illustrated in Figure 3.

Processing Techniques

Shop men have learned from experience that a given operation can be used to produce a certain specified microinch finish. Figure 4 shows some of the processing techniques available for producing certain microinch finishes together with typical applications and tolerances. Blueprints and working drawings often specify an acceptance roughness range for a given part, such as 32 to 64 microinches. This means that 32 microinches is the minimum roughness allowable and 64 the maximum. Through extensive experimentation by engineers in a variety of industries, it has been found that to overfinish a part is as costly as to underfinish it. Often finishing operations are employed which only increase the cost of producing the part and do very little or nothing at all to improve its function. Many times a part will give better service when slightly rougher than the specifications call for. The government and private industry are in the process of establishing specifications for parts where the control of surface finish is important.

Controlling Surface Finish

The following steps are suggested for controlling surface finish.

1. Check the drawings and shop prints for correct specifications.

TABLE OF DEFINITIONS

"2-1 *Surface.* The surface of an object is the boundary which separates that object from another object or substance.
"This standard* relates to surfaces produced by such means as machining, abrading, extruding, casting, molding, forging, rolling, coating, plating, blasting or burnishing.

"2-2 *Nominal Surface.* The theoretically accurate design, the shape and extent of which is usually shown and dimensioned on a drawing or descriptive specification.

"2-3 *Surface Irregularities.* Deviations from the nominal surface including roughness and waviness.

"2-4 *Profile.* The contour of a section perpendicular to a surface unless some other angle is specified.

"2-5 *Roughness.* Relatively finely spaced surface irregularities, the height width and direction of which establish the predominant surface pattern. Irregularities produced by cutting edges and machine tool feed may be considered roughness.
"The height is rated in microinches arithmetical average deviation from the mean line; the symbol AA being used as the descriptive abbreviation. For recommended values, see Section 3, Table 1.**
"The width is rated in inches as the maximum permissible spacing between repetitive units of the surface pattern. The roughness width shall be used to establish the roughness-width cutoff value which, unless otherwise specified, shall always be greater than the roughness width.

"2-6 *Waviness.* Irregularities of the nominal surface which are of greater spacing than roughness. These irregularities may result from such factors as machine or work deflections, vibration, heat treatment, or warping strains. The height is rated in inches as the peak-to-valley distance. The width is rated in inches as the spacing of adjacent waves. For recommended values, see Section 3, Table 2.**

"2-7 *Roughness-Width Cutoff.*"[1] The maximum width in inches of surface irregularities to be included in the measurement of roughness height.
"Roughness may be considered as superimposed on a wavy surface. For standard values, see Section 3, Table 3.**
The table referred to lists standard roughness-width cutoff values of 0.003", 0.010", 0.030", 0.100", 0.300", and 1.000".
"The value .030 is preferred for most surfaces and is to be used unless otherwise specified."

"2-8 *Lay.* The direction of the predominant surface pattern, produced by tool marks or grains on the surface ordinarily determined by the production method used.

"2-9 *Flaws.* Irregularities which occur at one place, or at relatively infrequent intervals in the surface, e.g., a scratch, ridge, hole, peak, crack, or check.

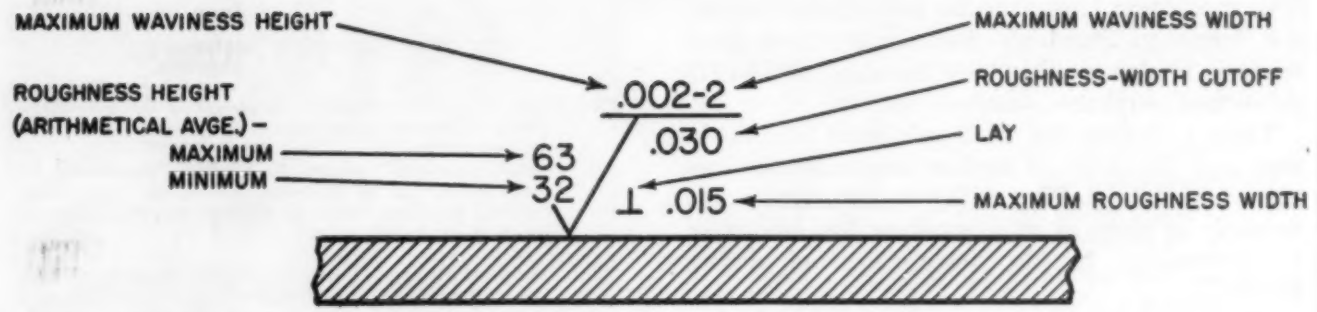
"2-10 *Microinch.* One millionth of an inch. (0.000001 inch)."

[1]The American "roughness-width cutoff" is equivalent of the British "sampling length." The American "sampling length" is equivalent to the British "traversing length."

*The complete copies of standard are obtainable at $1.25 each from the American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N.Y.

**The tables here referred to are not included in this article since their significance is relatively theoretical.

TABLE 1. Definitions quoted directly from the standard.

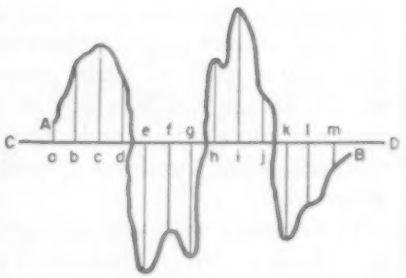


2. SURFACE SYMBOL with specifications for all the characteristics covered by the standard.

2. See that the right machining methods are used.
3. Be sure measurements are taken at the proper time.

This doesn't necessarily mean that every part coming off the production line must be measured, although this would be the ideal method in some cases. Spot checking, however, should be carried out at frequent intervals as a means of quality control. When the finish fails to meet specifications, it is wise to stop production immediately and replace the dull tool with a sharp one. Some shops have established a policy of automatically replacing tools after a certain period of time or number of parts, thus assuring uniform quality throughout. • • •

a = 4	a^2 = 16	
b = 19	b^2 = 361	
c = 23	c^2 = 529	
d = 16	d^2 = 256	
e = 31	e^2 = 961	
f = 20	f^2 = 400	
g = 27	g^2 = 729	
h = 20	h^2 = 400	
i = 31	i^2 = 961	
j = 13	j^2 = 169	
k = 23	k^2 = 529	
l = 15	l^2 = 225	
m = 6	m^2 = 36	
Totals 248	5572	



Arithmetical average = $\frac{248}{13}$ = 19.1 microinches

Root mean square average = $\sqrt{\frac{5572}{13}}$ = 20.7 microinches RMS

3. RELATIONSHIP of arithmetical average and RMS values determining surface roughness.

NOTE: Table showing summary and comparison of surface measuring techniques is shown on page 37.

	MICROINCHES							
Processing Technique	**1**	**2**	**4**	**8**	**16**	**32**	**63**	**125**
Hone	Possible	Possible	Possible	Recommended	Recommended	Recommended	Recommended	Possible
Lap	Possible	Possible	Recommended	Recommended	Recommended	Possible		
Grind					Possible	Recommended	Recommended	Recommended
Bore						Possible	Recommended	Recommended
Turn						Possible	Possible	Recommended
Drill							Possible	Recommended
Ream						Recommended	Recommended	Recommended
Super Finish	Possible	Possible	Recommended	Recommended	Possible			

Typical Application	**Gages**	**Instruments**	**Critical Bearings**	**Critical Seals High-Speed & Hi-Velocity Fluid Flow**	**Medium Bearings. Pressure Seals. Smooth to Touch & Heavy Slides**	**Quiet Gears Light Seals and Bearings**	**Gasket Seals and Light Slides**	**Non-Critical Slides Seals & Bearings**
Tolerance				.0002"	.0005"	.002"	.005"	.008"

4. PROCESSING TECHNIQUE generally recommended to obtain specified microinch finishes, together with typical applications and tolerances.

Continued from page 32

	Feel	*Tactual*	*Eye*	*Reflectivity*	*Air*	*Sectioning*	*Shadow*	*Interference*	*Profile*	*Averaging*
1. Micro-inch Range	32 up	2 up	32 up	2 up	32-500	10 up	100 up	2-100	2-8000	1-1000
2. Shapes	flat & od	flat	flat & od & id	flat	flat, & large dias.	flat, od, & id	flat	flat	any	any
3. Accuracy	——	35%	——	10%	——	10%	10%	10%	10%	10%
4. Effect on Surface	none	none	none	none	none	destroy	none	none	contacts	contacts
5. Dimension	none	height	none	percent reflected	air escape*	total height	total height	total height	total height	average height
6. Ease of Reading	poor	fair	poor	good	good	fair	fair	fair	fair	good
7. Ruggedness	good	good	good	fair	good	poor	poor	poor	fair	good
8. Time for Reading	short	short	short	medium	short	very long	long	medium	medium	short
9. Surface	area	area	area	area	area	line	line	area	line	line
10. Best Application	rough estimate	design	flaw location	when looks is main function	flatness	research	coarse soft surfaces	fine soft surfaces	quality control	production checking

*These dimensions do not necessarily correlate with surface roughness.

5. SUMMARY AND COMPARISON of surface finish measuring techniques.

BETTER CUT WITH BEAVER CUT CARBIDE

Cushion Ground and Micro-Lapped Rotary Files, Grinding Burrs, and Center Lapping Tools outlast regular ground carbide tools by 30% yet cost no more.

You may make a greater saving by sending us your dull tools for sharpening by our manufacturing method.

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World's most powerful and accurate hand!

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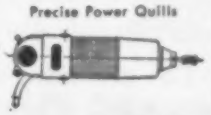
Precise Power Quills



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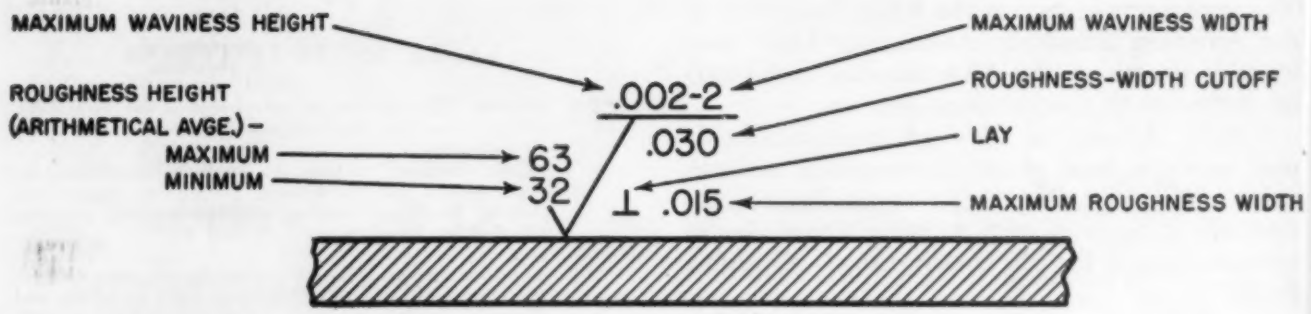

2. SURFACE SYMBOL with specifications for all the characteristics covered by the standard.

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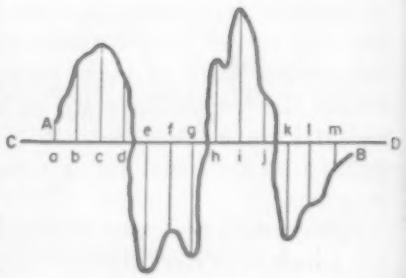

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Ream						Recommended	Recommended	Recommended
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4. PROCESSING TECHNIQUE generally recommended to obtain specified microinch finishes, together with typical applications and tolerances.

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Continued from page 32

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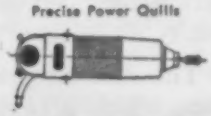

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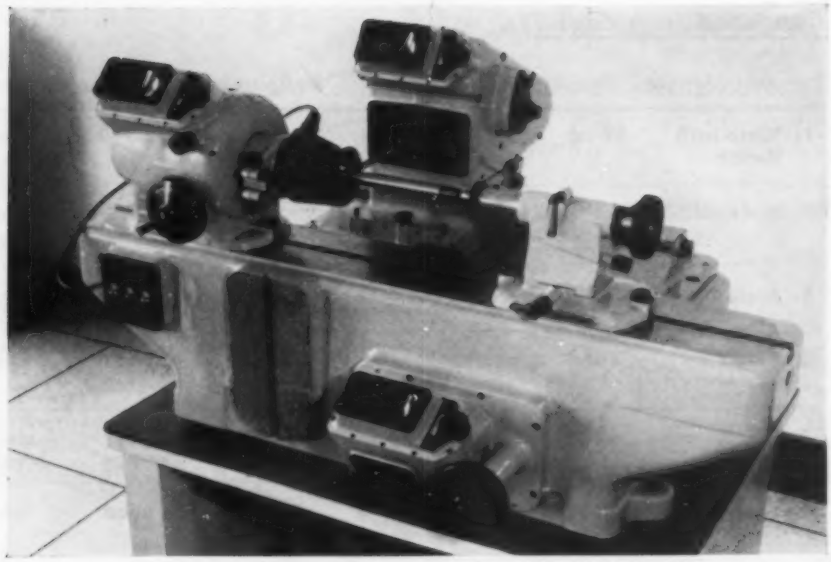
Optical Measuring Machine



SET-UP for checking three dimensional cams. Radial co-ordinates are read from the optical screens of the stylus ram and dividing head in a series of positions of the measuring head along the longitudinal slide.

. . . is especially adapted for the precise inspection of 3-dimensional cams

Supersonic Flight—Guided Missiles and other demanding modern developments have created a need for ultra precision in 3 Dimensional contour machining and 100% inspection.

By **John W. Mallory**
Vice President, Chief Engineer
The Parker Stamp Works Inc.
Hartford, Conn.

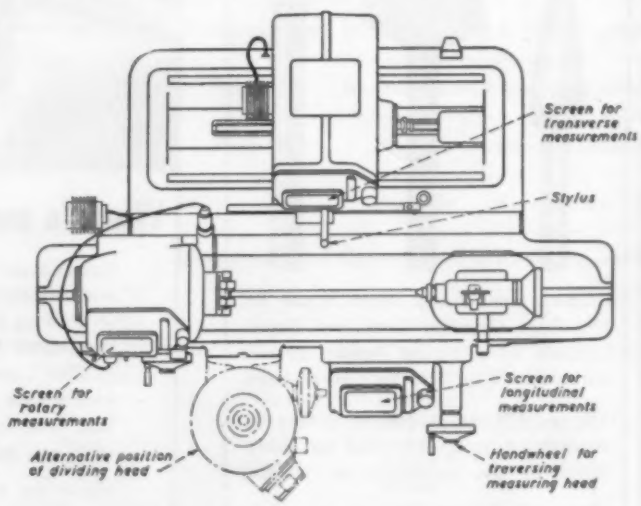
● Development of 3-dimensional contours and specifically 3-dimensional cams has resulted in a continual increase in the ultra-precise tolerances necessary.

Parker has added to its facilities an Optical Universal Measuring Machine capable of recording 3 separate dimensions simultaneously to tolerances of up to .00005". The machine is designed for measuring rectangular coordinate dimensions and controlled rotary movements of three dimensional cams.

The measuring stylus is mounted on a floating ram, which is supported on ten precision ballraces. The ram moves in a transverse direction, and carries a glass scale marked in .05" divisions which are projected on to vernier graduations on a screen reading to .005". The final measurement is taken from an optical micrometer graduated to .00005". In this way the optical system gives a magnification of x 1000.

In order to maintain a constant pressure on the work, the stylus ram is spring-loaded through a clockwork train and governor. A knurled head limits the forward movement of the ram to a pre-determined position, and the measuring pressure can be varied by an adjustment knob.

The ram and stylus head is mounted on a carriage moving on a longitudinal slide. This head also runs



TRANSVERSE, LONGITUDINAL AND ROTARY measuring movements are all read off screens on the P.G. universal optical measuring machine. The optical system provides a magnification of X 1000, enabling linear movements to read to .00005", and angle or rotation to .1 min.

ALTERNATIVE MOUNTING POSITION for the optical dividing head enables the profile of flat cams to be checked. In this set-up an extension stylus is being used.

on precision ballraces. A 12″ precision scale is attached to the longitudinal slide, enabling the position of the head to be read off a screen at the front of the machine, by means of an optical projection system similar to that of the stylus ram.

A standard P.G. optical dividing head is mounted on a bed in front of the measuring head, parallel to the measuring head slide. The projection screen of the dividing head enables the angle of rotation to be read to .1 min.

The standard stylus is interchanged with a stylus head allowing a limited lateral float to the stylus point for measuring steep slopes on two and three dimensional cams. The amount of lateral movement is indicated on a .0001″ dial comparator.

Radial Coordinates of flat cams up to 26″ dia. can be measured by mounting the dividing head on the front of the machine on the machined face.

When the dividing head is mounted horizontally the center height is 4-⅜″ and the maximum distance between centers is 20″. The range of the measuring ram is 0 to 4″, and the travel of the longitudinal slide is 12″. It is possible to vary these dimensions to meet special requirements. Five interchangeable ball styluses, ¼, ⅜, ½, ⅝, and ¾ dia. are supplied as standard equipment. The machine also has application for such operations as the checking of gears, threads, length measures and gap gages.

With the Universal Optical Measuring Machine, The Parker Stamp Works has solved the problem of establishing a known relationship between the three dimensional cam and its specified data, even with as many as 16,000 specified stations. • • •

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Shop Hints and Short Cuts

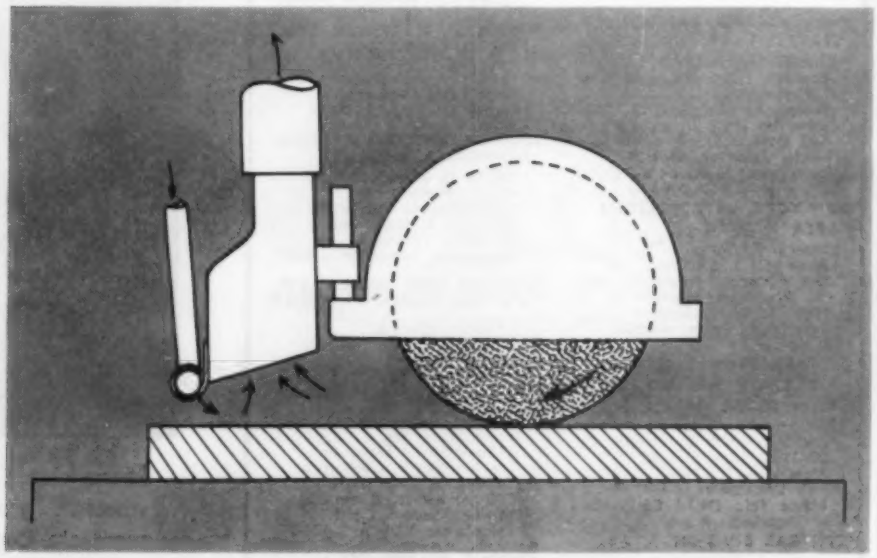
Improve Efficiency of Your Dust Collector

By **Clifford Molloy**

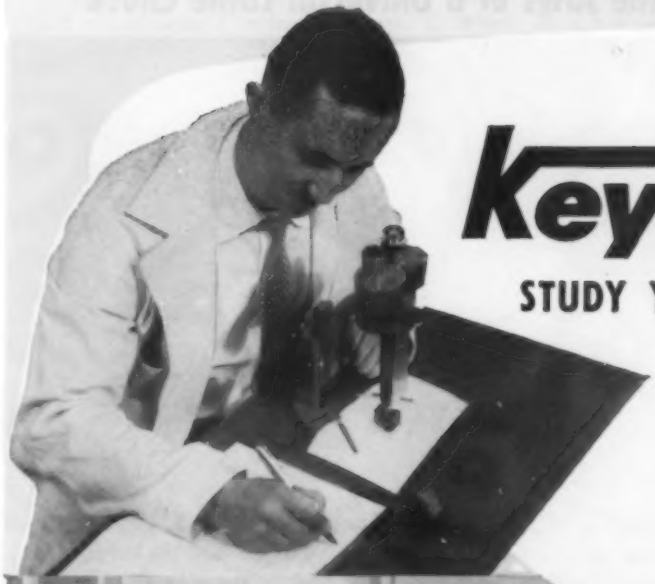
We have several surface grinders in our tool room equipped with exhaust systems to pick up the grinding dust. We have found that even when properly adjusted close to the work, much of the dust escapes past the suction intake. The chips of metal and abrasive leave the wheel at very high speed and just fly past the air rushing into the intake.

In order to improve the action and the efficiency of this dust collecting system we added a short piece of ⅜" pipe on the edge of the intake as shown on the drawing. The outer end of the pipe is capped and compressed air is fed to the inner end through a flexible hose. This hose is necessary to permit the wheel head to be raised and lowered. A pressure control valve is used to control the air flow.

A series of holes about .015" dia. are drilled along the center line of the pipe. The pipe is turned so the air is discharged down at an angle as shown in the drawing. These holes are spaced 1/16" apart. We use air at about 15 psi. This series of air jets produces a wall which stops the dust. When the air strikes the surface of the work, it reverses and flies up into the exhaust intake. We have found that this arrangement increases the efficiency of the system and at 15 psi it does not consume very much air. When experimenting with this setup, we found that the air flow is easily traced by blowing cigaret smoke toward the exhaust intake. • •



Do you use short cuts in your work? Do you have any kinks which would be helpful to the next fellow? Send them to GRINDING and FINISHING for publication. All material is paid for! Material can be in your own words, drawings can be rough pencil sketches; our editorial and art departments will do the rest. Send your Hints and Kinks to: Editor, GRINDING and FINISHING, 222 E. Willow Ave., Wheaton, Ill.



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Possibly you have been using the same wheel for years and are reluctant to change because of the bother of running trials. We have a suggestion for you. Let us survey your needs and work with a sample of your product in our labs. Keystone Abrasive Wheel makes these laboratories yours!

Our facilities include physical testing and chemical research labs, pilot plant, and grinding lab. Fill out coupon below, inviting our technical man to visit you.

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CARNEGIE, PENNSYLVANIA

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The abbot and the Bishop's Candlesticks

The Bishop was upset. How could he possibly have 500 dull, tarnished brass candlesticks polished and gleaming in time for tomorrow's special candlelight services?

The *abbot* was quite calm. He *knew* the answer to the Bishop's dilemma and in less than twenty-four hours, he returned from his laboratory with the candlesticks — bright and glistening.

How did he do it?

Articles made of brass and other metals may be readily burnished and tumbled with Abbott Burnishing Materials. Made in six scientifically designed shapes, Abbott Burnishing Materials make efficient and uniform contact on metal parts and castings of every conceivable size and shape. Economical to use, they are *deep hardened* and have a mirrorlike glass-hard surface for extra long life. Combined with the Abbott Vertical Tumbling Barrel, they make the perfect barrel finishing combination.

If you have a special barrel finishing problem, let the abbot help you solve it. Just write us.

ABBOTT

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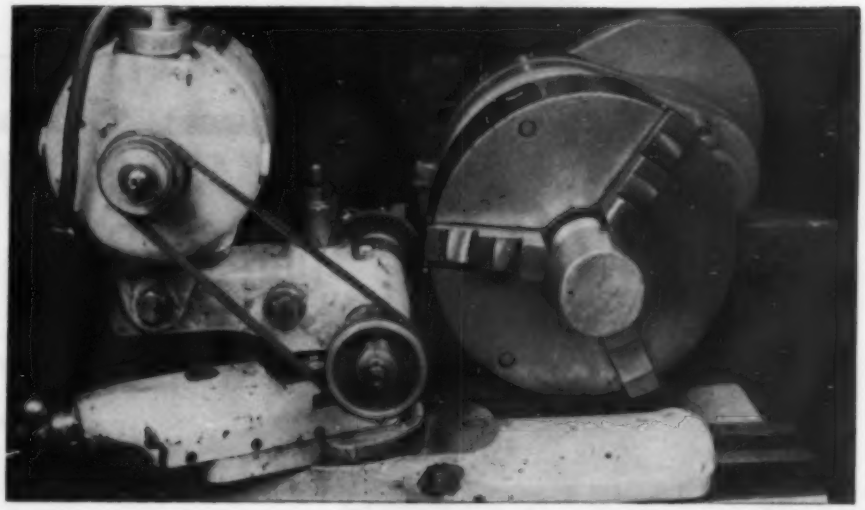
Re-Grinding the Jaws of a Universal Lathe Chuck



Step No. 1. Grind peripheral surfaces of three jaws while jaws are gripped tightly on piece of round stock.

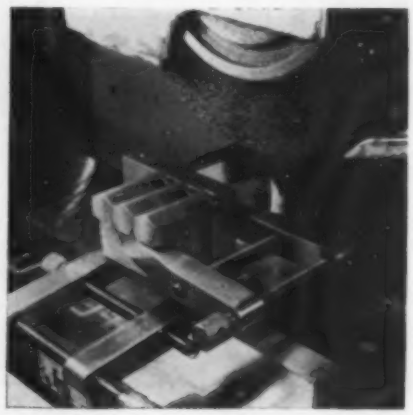
By **H. J. Gerber**

We have made successful use of the following method for re-grinding the gripping faces of a universal lathe chuck: The chuck is first mounted on the spindle of the lathe on which it is to be used. A piece of truly round stock is next gripped tightly in the jaws, preferably near the outer ends of the jaws in the position in which many small jobs are often held. A tool post grinder is next mounted on the carriage and a clean up cut is taken on the exposed peripheral surfaces of the three jaws.

The three jaws are then removed from the chuck and mounted on the surface grinder with the previously ground surfaces seated clean on the magnetic chuck. The jaws are clamped tightly against an angle plate for support and all three gripping faces are then ground to a common plane and parallel with the peripheral ground outer surfaces.

This method will usually prove successful in truing badly worn jaws to within a couple of thousandths. In some cases where the scroll is badly worn it will be found necessary to remove a few extra thousandths from one individual jaw face after indicating the point of greatest runout.

It will be necessary to use care in mounting the chuck clean on the lathe spindle nose when making the peripheral grind. • •



Step No. 2. Grind gripping faces of all three jaws. Jaws are seated on previously ground peripheral surfaces.

Simplified Method of Shoulder Grinding

By **Peter C. Schultz**

Although we are in agreement with Christopher Hill's method of shoulder grinding which appeared in the June issue, we believe it is too time consuming and costly when the situation arises in our shop. The method we use has proven to be simple, fast and positive.

First the side of the wheel should be recessed, depending on the depth of the shoulder, leaving 1/8″ of the wheel to contact work. Secondly, set taper in the machine to 0° by grinding OD on sample piece that is the same length as the job to be ground on the face. Next put the piece to be ground into the machine and without revolving the piece bring the wheel in contact with the shoulder of the work. Note whether it grinds on the top or bottom of the face. Then either shim up the tail stock or head stock to compensate for wear. Usually you will find that the tail stock will have to be raised, because it is moved more often in set-ups. You will know you're in perfect alignment as soon as a perfect arc appears on the shoulder. Then revolve the work and grind a piece.

A criss cross pattern is the result, which will indicate a perfectly flat and square surface. After a few pieces the criss cross pattern will gradually fade out. This is due to the glazing of the wheel. It is nothing to be concerned about, because the amount of error will be very slight. • •

Emergency Coolant Filter

By H. J. Gerber

Occasionally we find it necessary to cylindrical grind an exceptionally fine finish on certain experimental jobs. Our grinder is not equipped with a coolant filtration unit and we find that a settling tank alone is not adequate to remove finely suspended swarf particles from the coolant. It is well known that these small metal particles will be the cause of microscopic scratches on the finish of the work so we make use of the illustrated emergency filter.

A small cloth bag is packed with cotton waste or wadded cheesecloth and tied around the coolant spout. The packing material should completely surround the spout opening so that all coolant will have to pass through this material.

This method is effective if used for only short run jobs and may become ineffective after about 30 minutes use.

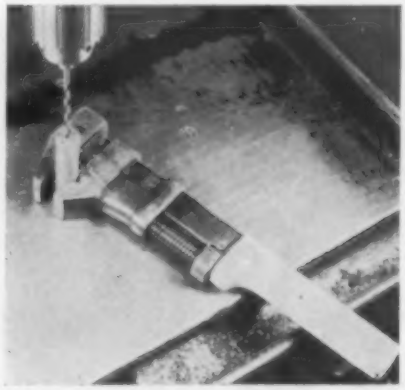
"V" Notch in Wrench Jaw For Drill Press Use

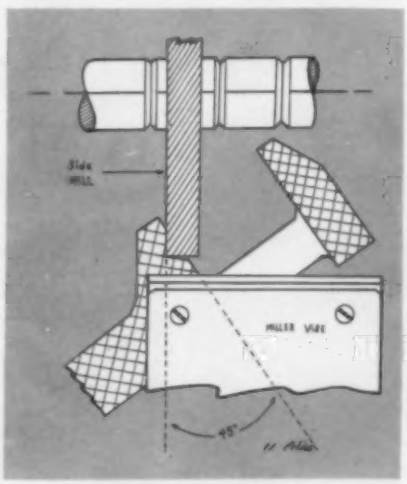
By **H. J. Gerber**

The old fashioned monkey wrench has pretty well become obsolete for general shop use. However, I believe it is still the best all-around tool ever developed for gripping small work on the sensitive drill press.

It is, in effect, a small parallel jaw vise equipped with a handle. On many of our small drill presses we secure a wrench of this type to the machine with a light weight chain to be sure that it is always available when needed.

I have found that the usefulness of this tool is considerably increased if an accurate 90 degree "V" is milled in the movable jaw. The wrench will accurately position and hold small round pieces as well as the usual variety of squares and flats. • •





Monkey wrench has "V" notch cut into movable jaw to facilitate the accurate holding of small round pieces being drilled.

PRESSURELOK-224

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— the best diamond wheel bond ever developed —
if you've used them - you know they're best!
if you haven't - let us show you!

UNITED STATES DIAMOND WHEEL CO. AURORA, ILL.

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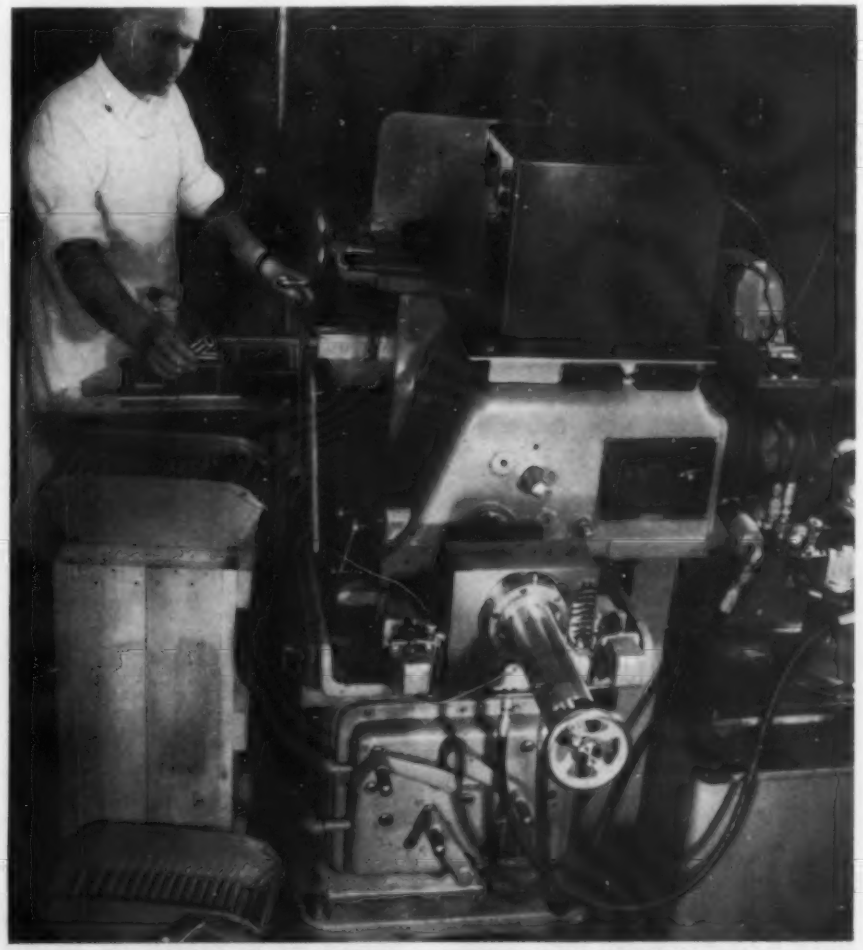
What's New in Equipment and Materials

Size Control In Microinches

The Inchworm Motor, a new linear actuator developed by Airborne Instruments Laboratory, Inc., Mineola, New York, to provide an extremely precise feed control for centerless grinders, offers controllable feeds in increments of microinches. Offered as a successor for the lead screw in applications requiring dimensional control in the range of 5 millionths up to one ten-thousandth inch, Inchworm units have been built for a number of plants for centerless grinders producing precision hydraulic components.

The name Inchworm has been applied to the revolutionary actuator, not



1. GRINDING PISTON RINGS for Ford at the pilot-run plant of Airborne Instruments Laboratory, Inc., Mineola, N. Y.

as an unusual title, but rather as a description of its operation—the Inchworm literally steps along in microinch steps, expanding and contracting like its familiar name sake. Employing a physical phenomenon called the magnetostrictive effect, the nickel armature of the motor shrinks in length under the influence of an electromagnetic field, snapping back to original size when the magnetic field is de-energized. A pair of clamps cooperating with the armature convert the alternate expansion and contraction into forward or backward motion, figure 4, reversing on demand without backlash.

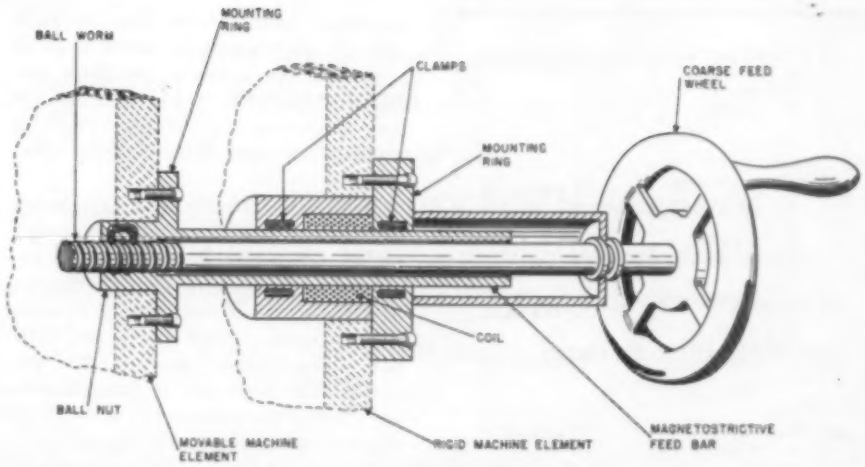
To accomplish its job of feeding the regulating wheel slide in such small increments, the Inchworm must overcome the "stick-slip" factor involved when moving one heavy machine element with respect to another. This factor causes the break-loose force of one member sliding with respect to the other to be greater than the force required to maintain a slow steady velocity.

The Inchworm actuator has brought the stick-slip problem under control, reducing by a factor of 15 the minimum increment of slide motion as compared with conventional feed mechanisms. These installations have reportedly provided repeat accuracy of ± 5 millionth of an inch under machine load conditions requiring a break-loose force of 300 pounds and a sliding force of 220 pounds, on a Cincinnati No. 2 centerless grinder.

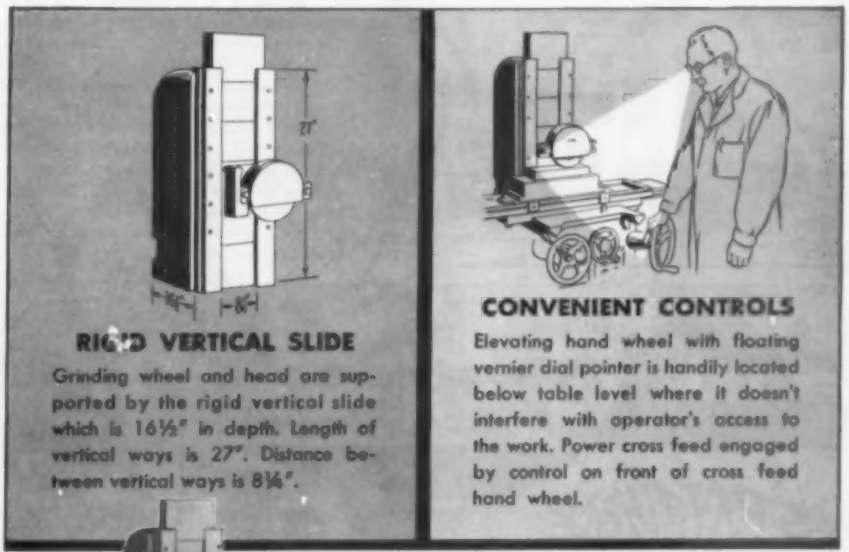
A very rigid connection between machine elements is accomplished with the Inchworm unit because no lead screws, split nuts or bearings are in the path of force transmission. In addition, since no lead screw is employed, there is a positive improvement in the spring system constant due to elimination of the torsional factor customarily introduced by the lead screw member. The resultant system is extremely rigid, yet reversible and essentially free of backlash.

Figure 4 diagrammatically illustrates the Inchworm step cycle in which the

2. PISTON PIN grinding for Ford.



3. CUTAWAY OF INCHWORM ACTUATOR shows the component arrangement of the motor. Each clamp consists of a fluid-filled cylindrical groove covered with a membrane which contacts the armature. When hydraulic pressure is applied to the membrane, it deforms and presses against the armature, forming a friction lock. Coarse feed wheel is provided for set-ups, acting through ball worm-nut components.



RIGID VERTICAL SLIDE

Grinding wheel and head are supported by the rigid vertical slide which is 16½" in depth. Length of vertical ways is 27". Distance between vertical ways is 8¼".

CONVENIENT CONTROLS

Elevating hand wheel with floating vernier dial pointer is handily located below table level where it doesn't interfere with operator's access to the work. Power cross feed engaged by control on front of cross feed hand wheel.

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HAND OR POWER FEED

SURFACE GRINDER

6" x 18" x 15"

Engineered to give you the most accurate gage, form tool and surface grinding performance for a low initial cost.

HARD CHROME TABLE WAYS

Hard chrome plating preserves the original built-in accuracy. Chrome is applied direct to alloy cast iron surface of V and flat table ways after they are precision hand-scraped.

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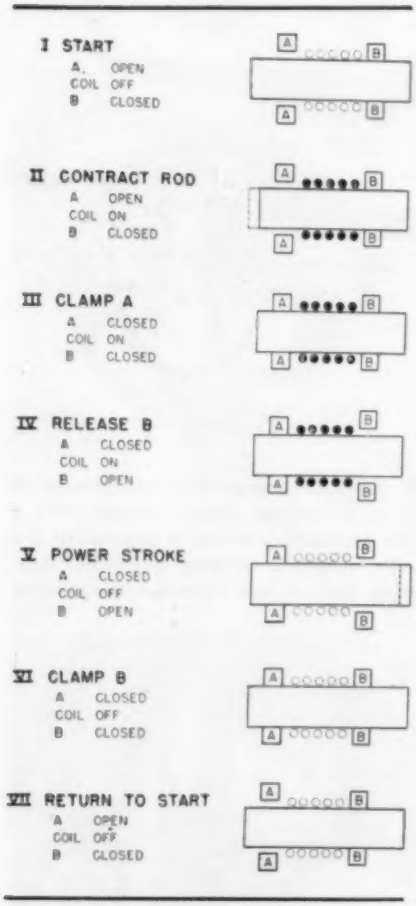

armature moves from left to right through the clamps in response to six sequential operations of the three control elements—the two clamps and the coil. Reversing the sequence will reverse the direction of travel of the armature.

For manual control, a single-step push-button and a repeat-step switch are employed, together with a step size control in the form of a simple rheostat or variable transformer control element. For automatic control, a gage and statistical programmer provide the step signal. The step size is controlled by variation of the amount of current flowing through the magnetizing coil.

Since machine operations require a coarse or set-up feed control, the Inchworm motor is arranged with a coaxial coarse feed wheel as illustrated in the cutaway, figure 3. The coarse feed wheel operates through action of ball worm-nut components. In practice, the Inchworm vernier feed overrides the ball worm and nut, allowing the coarse feed wheel to be used only when both clamps of the fine feed mechanism are relaxed. When the machine has been set up, the size control function is given to the Inchworm in cooperation with a gage response system—either human or electromechanical.

4. HOW IT OPERATES—The magnetostrictive armature is supported in a pair of coaxial clamps (A, B) spaced to provide a desired maximum step size. Motion is produced by magnetically shrinking the armature while clamp (B) is locked and clamp (A) is unlocked. This moves the left end of the armature to the right. Clamp (A) is then locked, clamp (B) released and the armature expanded by removing the magnetic field. Now, the right end of the armature has moved to the right and a net motion between the two members has occurred.

In semi-automatic operation, the operator of the grinder in checking the machine output may decide that he requires, for example, a fifty millionths infeed to compensate for wheel changes. By turning a single dial to fifty and pressing one button, he accomplishes the required infeed quickly, accurately and dependably. Set-ups are said to be much simpler, even for inexperienced operators. Using an electronic gage to monitor the regulating wheel position during setup, it is said that the slide can be repeatedly and accurately positioned within 5 microinches of desired position.

Fully automatic Inchworm systems employ AIL post-process contacting gages to detect size variations to an accuracy of less than 10 millionths of an inch. In such systems, the gage feeds control circuits which average errors over several pieces. •

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SPITFIRE

Lapping Machines
For every lapping job!
Whatever your precision finishing requirements, Spitfire has the lapping machine custom designed for your piece parts, your production speed, your cost schedules. For unexcelled quality control at savings—contact Spitfire today!

The New
GYRO-MATIC "21"
Now . . . automatic flat lapping that saves time, money, work! Push button operation with many outstanding new features . . . produces optical flatness to .0000116!

"24" Flat Lapper
Low cost, super fine mechanical finishing. Lapping plate eliminates distortion.

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The scientifically designed features of Model "24" in a money-saving 18" lapping surface.

Cylindrical Lappers
Micro-inch lapping of plug gages, cylindrical parts, shoulders, etc. Closer tolerances in 1/3 the time!

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- **At last...*low cost* coolant clarification that provides...**
- **Longer coolant life.**
- **Eliminates costly filter replacements.**
- **Insures fewer grinding wheel dressings... less down time for tool replacement.**
- **And takes out *every* type of contaminant!**

NEW DE LAVAL TURBO-COOLANT CLARIFIER

The new De Laval Model 115 Coolant Clarifier is designed for *individual use* on grinding, honing or turning units... takes up minimum floor space (2 feet diameter by less than 2 feet height)... gives you complete efficiency with amazing low cost!

This new De Laval Coolant Clarifier handles all types of coolants—both oil and aqueous... can be supplied with a skimming device for handling volatile liquids.

Get all the details on De Laval's *new* Turbo-Coolant clarifier... that offers great new advantages at unmatched low cost!... *today.*

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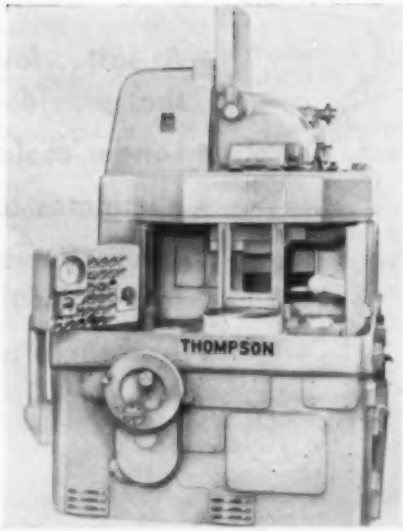
Twin Rotary Production Grinders Save Circular Grinding Time

The Thompson Grinder Co., Springfield, O., has announced the completion of a new line of twin rotary circular grinders with table work surfaces from 6 to 24 inches. The new Thompson Type TR twin rotary grinder is said to reduce cycle time 40% because the operator loads one magnetic chuck at front position while another part is being ground automatically in rear position.

Typical job applications include automotive gear clusters, aircraft turbo-jet blades, automotive transmission gear faces, circular metal saws and many other intricate parts. The gear cluster illustrated is SAE 5135 being finish ground with stock removal of .008″ to .010″ and tolerance of plus or minus .0015″ finish—25 microinches.

The automatic machine cycle is as follows: Operator starts machine cycle by pressing cycle start button. Wheel head moves downward contacting the work piece, rapidly and accurately, removing predetermined amount of stock. Then spark out cycle occurs. Wheel head returns to up position, operator unloads ground parts and grind cycle starts automatically in rear position.



Type TR twin rotary production grinder.

Typical grinding job on an automotive gear.

Features include: Horizontal wheelhead grinding with 14″ or 20″ diameter wheel to controlled size with automatic compensation of the feed screw; free loading time enabling operator to arrange other parts or operate other machines; in-position wheel truing to dress wheel automatically, pre-set and to machine cycle; assured accuracy of finish with automatic wheel truing and spark out; maximum rigidity with work table supported on large bearing surface. •

Use HANDY Postpaid Card. Circle No. 102

New Device Facilitates Grinding of Taps

An inexpensive fixture for regrinding taps has been introduced by Radial Reliever Co., 63 Myrtle St., Worcester, Mass.

This device embodies a mechanism which allows instantaneous setting for the correct number of flutes and for the amount of relief being ground.

Three models provide a capacity from No. 0 to 1½ dia. taps. A fourth model grinds bent shank tapper taps. By this method any tap can be ground in a few seconds. The low cost of this device places it within the reach of the smallest shop. •

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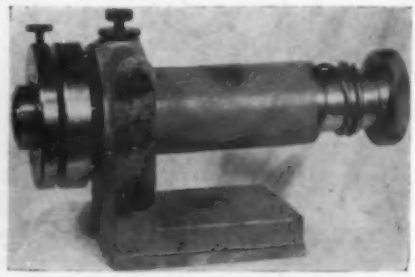

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. . . TIME FOR AN *AIR MASTER* when "sandpaper-air" drips enough dust on benches and equipment to attract a doodler.

Air borne and collecting dust can reduce equipment to "dirt cheapness." It can injure the health of your employees. Dust can and does cost you money.

If you grind, buff and polish, you need *The Cincinnati Air Master* . . . for new equipment, and for that already in operation. Closely woven fabric and steel wool filters "wash" aggravating dust and grit laden air. Grinder or buffer switch starts or stops *Air Master* simultaneously. Compact, quiet operation; easy to clean.

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Division of The R. K. LeBlond Machine Tool Co.

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Abrasive Belt Surfacer Cuts Machining Time on Tire Mold Parts

Use of abrasive belt grinding for fabric plates by the Akron Equipment Co. achieved a 25 to 1 increased stock removal rate over a milling operation. The plates, used to secure tires inside tire molds during the final curing operation, are of 1012 steel, 1½ in. thick and varying in length from 3 in. to 12 in. Maximum stock removal for the contouring operations is ⅛ in.

Curved steel segments used in tire molds are finished on the belt grinder shown. Belt grinding increased stock removal 2400% over milling, eliminated fixture costs.

The firm encountered excessive tooling and considerable downtime with the former milling operation. Filing and remilling were often necessary to obtain a satisfactory fit. This kept the average finishing rate down to five pieces an hour. Results of methods testing led to the installation of an abrasive belt surfacer. The wet-or-dry belt model utilizes the platen method of belt grinding. The operator manually surfaces the plates against a straight section of the belt which is supported by a hardened steel platen. Dry belt used for stock removal is 9 in. wide, aluminum oxide 36 grit, run at 4100 sfm.

Requiring no fixtures, the belt grinder has eliminated reworking and rejects. Net grinding time on each plate was cut from 12 minutes to 25-30 seconds. •

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Vertical Version of the Automatic Internal Grinder

Bryant Chucking Grinder Co., Springfield, Vt., has announced the introduction of a special vertical version of its new Centalign automatic internal grinding machine. This new machine, a vertical cam grinder, incorporates the principal features of the standard Centalign, such as greater rigidity and stability; faster stock removal and greater accuracy; workhead, wheelhead and longitudinal and cross slide motions of the wheelslide in one common plane, in order to reduce deflections to a minimum, and to insure permanent alignment.

Machine function is controlled by programming cam sets which can be readily interchanged. A simplified hydraulic servo-control system combining the advantages of both cam and hydraulic machine operation gives accurate machine control and extremely smooth responsive operation.

Typical of the uses of the vertical version of the Centalign is the grinding of 2-lobed bores in hydraulic pump parts at the rate of 130-140 pieces per hour. This compares with a production rate of 30 pieces per hour obtained by previous methods.

Work parts are hand-loaded into a special chuck, rotating at 100 rpm. •

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Vertical version of the Bryant Centalign automatic grinder, shown with guards removed.

Production CENTERLESS

TYPE 101
HIGH SPEED

GRINDING & FINISHING MACHINE

Bars and tubes given high polish at rate of 100 FEET PER MINUTE!

Production's type 101 High Speed machine shown here in tandem regularly produces up to 100 feet of highly polished steel bar or tube stock per minute prior to chrome plating. Buffed surfaces on aluminum or other non-ferrous metals can be provided with equal ease.

These versatile machines can accommodate work up to 4" in diameter for abrasive belt finishing, buffing, or a combination of both.

Our Demonstration Laboratory is ready to process a sample lot of your material. Write Dept. C today for complete details.

PRODUCTION MACHINE CO., Greenfield, Mass., U.S.A.

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SHORTCUTS in lapping and finishing

New

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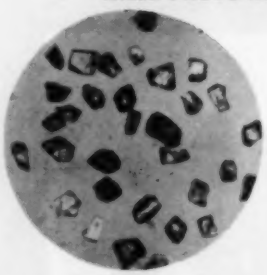
Diamond Compound

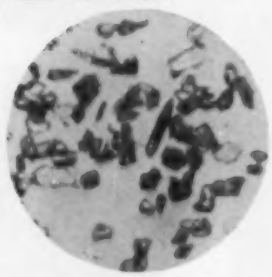
provides faster cutting speeds, far more uniformity, finer finishes!

Di-Met Compound is the result of new diamond crushing techniques which produce large quantities of *compact, chunky particle shapes.* Because of their extra strength and numerous cutting edges these particles produce more work, cut faster and resist breaking down. Unmatched uniformity of size eliminates gouging and scratching from oversized particles, reduces polishing time. Combine these advantages with a vehicle which is not only *water soluble,* but which won't throw off under centrifugal force and waste precious diamonds... that's Di-Met Compound... *fast acting, economical and easy to use*... a *bigger value* for your lapping and finishing dollar!

THESE PHOTO MICROGRAPHS TELL THE STORY

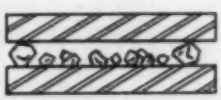


Compare the shapes of the Di-Met diamond particles at left to ordinary diamond compounds at right. Note absence of flats, fines and foreign material. Every particle is properly sized. . .your guarantee of a faster, better finish!



This photomicrograph shows why some diamond compounds are slower working. Notice the flats and splinters, shapes which lack strength and break down quickly. The smaller sizes produce no effort whatever, yet cost you at the same rate as the "workers."

Di-Met Carbide Micro-Inch Finisher
Newest method for obtaining a micro-inch finish on your carbide and ceramic cutting tools. These finishes can increase tool life as much as 800% with higher cutting speeds and faster feeds. Literature available.



Left: Here's what happens when off-size diamond particles are included. Small particles never make surface contact, large particles produce deep scratches which are costly and time consuming to remove.

Ask for the name of your nearest Di-Met Distributor. He will gladly demonstrate the difference in Di-Met quality—or write for descriptive literature!

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Centrifugal Coolant Clarifier

Just introduced by The DeLaval Separator Co., Poughkeepsie, N.Y., is their new Model 115 coolant clarifier. Working on the principle of a low-speed centrifuge, the new unit takes dirty coolant from operations such as honing and precipitates particles as fine as 10 microns out of suspension by centrifugal force, returning the clean coolant to a sump for reuse in the machine.

Compact size of the clarifier and its price range indicate that it is intended primarily for individual machine installation. The unit will handle a flow up to 20 gallons per minute, depending on the viscosity of the coolant and the nature of the contamination.

An important advantage of the centrifugal type clarifier is that it will remove non-ferrous particles such as aluminum, bronze, and spent abrasive, as well as iron and steel sludge and chips. Another is that very little maintenance attention is required for continuous operation, since there are no filters to change. The centrifuge basket is accessible and easily removable for the infrequent cleaning necessary.

The unit is powered by a 1½ hp foot-mounted NEMA frame motor, which turns the 16-inch ID cast aluminum basket by means of multiple vee-belts. Coolant is introduced into the clarifier through a gooseneck integral with the lid into the bottom of the centrifuge basket so that all suspended matter can be precipitated before the clean coolant spills over the lip of the basket.

A pilot installation of the new unit has been operating in the job honing department of Micromatic Hone Corp. in Detroit, connected with one of Micromatic's vertical single-spindle honing machines. In this installation, where coolant flow is approximately 5 gpm, the DeLaval clarifier has demonstrated efficient operation on the wide range of materials being honed in the department. Typical honing fluid used by Micromatic is a Sinclair Union base (12% Sulphur) oil mixed 10-15% with kerosene. •

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Model 115 DeLaval coolant clarifier with aluminum lid removed reveals centrifuge basket which removes contaminants of all kinds from honing operations. Unit will be offered as optional equipment on Micromatic Hone Corp. machines.

Flat Lapping Machine Features Economy Plus Volume

Economy has been coupled with the production line speed and volume capacity of large flat lapping machines with the development of the new Model 18 lapping machine manufactured by the Spitfire Tool Co., 2931 N. Pulaski Rd., Chicago 41, Ill.

Featuring an 18″ dia. lapping plate, the Model 18 is designed as a versatile flat lapping machine capable of producing microinch finishing for both small and medium size piece parts such as gages, sliding and rotating parts, air and liquid tight seals, valves and many other parts requiring precise lapping. The ease with which this machine attains optical flatness to a smoothness of 2 rms or finer assures maximum production line output to the highest standards of quality control at important savings of time and labor. Operators of little lapping experience

can produce flat lapped parts to exact tolerances. Set-up time is almost completely eliminated since no collets, chucks or holders are used.

Since ultra-precision lapping is the primary goal of this machine, great care has gone into the design and manufacture of the lapping plate. It is constructed according to Spitfire's own specifications of close grained cast iron exactingly heat treated to prevent distortion. The surface of this plate undergoes a special machining and grinding process to comply with the super-fine accuracy required of it during the lapping operation. The lapping plate is firmly supported by six precision hardened and ground, permanently sealed ball bearings. These ball bearings are mounted on hardened and ground eccentric bushings permitting uniform adjustment with ease. All moving parts are permanently sealed and lubricated. •

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We've been in there PITCHING... for 80 years!

DAYTON SAFETY GRINDING WHEELS

Most of our "ringers" were made solving the "hard-to-do" grinding jobs of our customers.

Routine or standard grinding jobs we take in stride.

Like to "pitch" one of your hard-to-do problems our way and see what we can do with it?

Write for details or the name of your nearest distributor.

SIMONDS WORDEN WHITE COMPANY

1101 Negley Place • Dayton 7, Ohio

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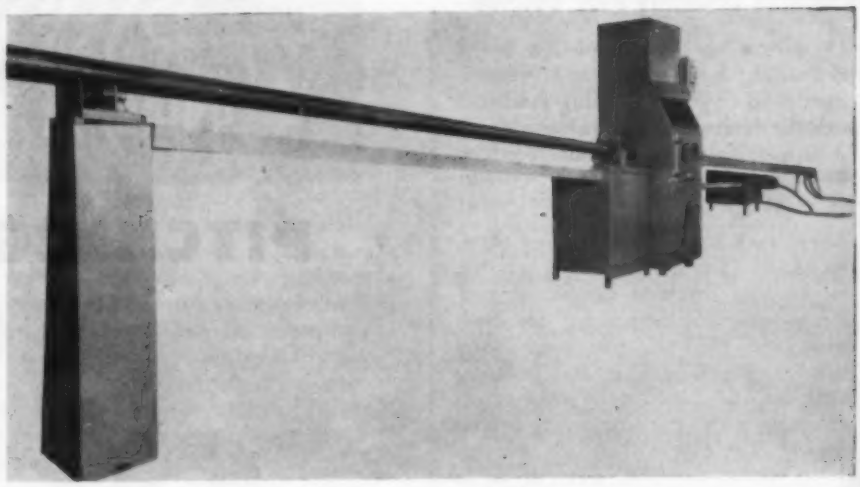
Pressure Blast Unit for Internal Diameters

A new, automatic pressure blast wet blasting unit, designed for the removal of pits, nicks and scratches from the internal diameter of helicopter rotor blades, has been developed by the Cro-Plate Co., Inc., 747 Windsor St., Hartford 1, Conn.

In operation, the blade 22 feet long and approximately 4 inches in diameter is rotated while a blast gun strokes through the interior of the entire length. A cycle is completed when the blast gun is returned from the "through" stroke.

After Pressure Blasting the part is rinsed in plain, cold water and immersed in a light soluble oil for the prevention of rust. •



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Gentlemen:

I'd like to have complete information on your spindle repair service.

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Firm_____

Address_____

City_____ Zone_____ State_____

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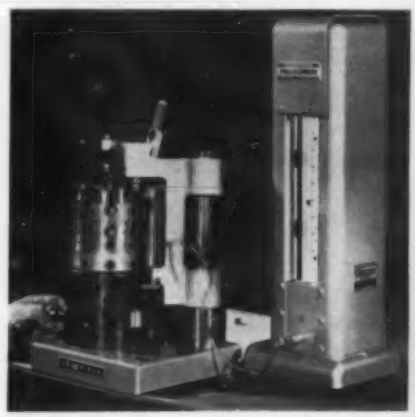
Air Gage Used To Measure Bolt Stretch Under Tension

A Precisionaire gaging device for measuring how much a bolt stretches when tightened in an assembly has been developed by The Sheffield Corp., Dayton 1, O.

In the accompanying photograph, an aircraft accessory assembly is shown in bolt tightening and gaging position. When the operator tightens a bolt, the amount it lengthens is indicated by the



position of the float in the gage at the right. Bolts are tightened and gaged individually. By bringing each bolt measurement to zero on the scale, the operator knows that all of the bolts are of equal tension.

The gage will accommodate variations in bolt length. A lever operated cam mechanism retracts the locating pin and gaging pin so that the part can be revolved to the next bolt without being raised.

The pivoted arm-type mechanism has a floating reference point at the top which contacts the head of the bolt. There is also a pneumatic Plunjet gaging cartridge at the bottom which is activated by the gaging pin that contacts the end of the bolt. •

Use HANDY Postpaid Card. Circle No. 109

King of the wide frontier

Installed for experimentation at CARBORUNDUM's Coated Abrasives plant in Niagara Falls, this spectacular new precision belt-grinding machine grinds a single piece 40 feet long by 86 inches wide *in one operation*. It's the largest machine of its kind in the world, and it opens brand new frontiers in grinding to close tolerances on many previously "impossible" jobs. By quick changes of abrasive belt, any variety of micro-finishes can be obtained. Even precision tapers and complex profiles are achieved automatically. CARBORUNDUM's many years of engineering skill in solving abrasive belt problems for industry resulted in this new wide-belt concept of precision grinding. For complete information write The Carborundum Company, Niagara Falls, New York. In Canada: Canadian Carborundum Company, Ltd., Niagara Falls, Ont.

Through application "know-how" and product quality

CARBORUNDUM

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continually puts more sensé in your abrasive dollar

Your best first step in giving dull cemented carbide tools a new lease on life is to select a "Green-Grit" silicon carbide wheel by CARBORUNDUM. For milling cutters and other multiple-point tools, where finer finishes are required, "Green-Grit" resinoid bond wheels offer superior form-holding ability. Even with heavier infeeds, they cut free and cool. In roughing operations, where stock removal is more important than finish, you'll find "Green-Grit" vitrified bond wheels your best bet. They permit both steel and carbide to be ground together—with outstanding results.

Your CARBORUNDUM Distributor or salesman can help you choose the right "Green-Grit" wheel for every job. Call him today. For Booklet A-1208 on carbide grinding, write The Carborundum Co., Niagara Falls, N. Y. In Canada: Canadian Carborundum Co., Ltd., Niagara Falls, Ont.

Through application "know-how" and product quality

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continually puts more sense in your abrasive dollar

New Lapping Machines Permit Flat Lapping of Shoulder Faces

Flat lapping of shoulder faces, as well as other lapping, can now be done with a new Lapmaster tooling arrangement that consists of a 12-in. grooved lap plate mounted in the center of a 24-in. lap plate. This permits the lap-

ping of shoulder faces, such as the aviation fuel pump parts illustrated. The 12-in. lap plate can then be removed to permit lapping of other work pieces on the standard Lapmaster. This tooling effects a considerable savings, since it eliminates the cost of purchasing a complete machine for this type of lapping.

The new tooling arrangement is equally adapted to many other parts where precision finish and flatness are required. These include valve bodies and discs such as those used on diesel locomotives. Valve bodies of this type have a protruding stud. Thus, the 12-in. lap plate can be used for the valve body with the stud, while the 24-in. lap plate with conditioning rings is used for compressor discs and other flat parts. This tooling arrangement can also be supplied to fit the new 36-in. model Lapmaster. Crane Packing Co., Dept. GFN, 6400 Oakton St., Morton Grove, Ill. •

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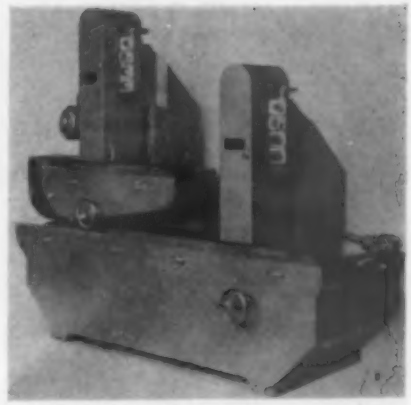
Two-Side Conveyor-Type Abrasive Belt Grinder

For high-speed precision surfacing both sides of flat parts a new two-level conveyor-type belt grinder has just been introduced by Engelberg Huller Co., 831 W. Fayette St., Syracuse 4, New York. This wet-or-dry belt grinder features a dual conveyor arrangement, with turnover hopper device. It is designed to grind both sides of ferrous and nonferrous metals, plastics, glass, ceramics, and other materials in a single automatic cycle.

Parts are carried under the upper grinding head on a 10½" x 107 abrasive conveyor belt, and automatically turned over in a gravity feed hopper. The lower conveyor belt, 10½" x 206, carries them under the second head for grinding the reverse side.

The two-side belt grinder is particularly adaptable to automatic production lines. Parts can be conveyorized for presentation to the machine's upper conveyor belt, automatically ejected from lower conveyor belt, and carried to next operation. The turnover hopper device can be sectionalized for smaller parts.

Speed of conveyor belts with ½ hp conveyor drive, is 2 to 25 feet per minute, with higher speed ranges available for special applications. For operator safety, the machine will not start unless the belt is tensioned. Control panels include tension safety light and conveyor reversing switch.



Size of abrasive belts is 10 x 92 inches, and belt speed is 5500 sfpm. Magnetic chucks are optional. The machine is 102 inches long, 42 inches wide, and 88 inches high, and is equipped with 7½ hp drive. Approximate shipping weight is 6055 pounds. •

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no one has ever paid for service
There's never been a charge . . . never . . . for factory service on a Fulmer Honing Machine! And Fulmer Service is far more than an empty phrase. A company airplane is maintained to deliver service personnel and replacement parts, often in a matter of hours to meet an emergency. Fulmer machines offer the following added advantages:
FASTER . . . EASIER . . . MORE ECONOMICAL PRECISION-HONING OF INTERNAL BORES
. . . for FULMER HONING MACHINES
FULMER
Amazingly fast . . . stock removals up to 1¼ cu. in. per minute; geometrically accurate . . . surface finishes down to one micro inch, rms . . . identical finish from hole to hole . . . generous overload capacity, etc.
Fulmer precision honing machines can do for you what they are doing all over the world — save time and money! Write for Bulletin on Honing to: C. Allen Fulmer Co., Dept. G, 107 E. 4th St., Cincinnati 2, O.
FULMER honing equipment

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Lets You See Work Clearly Where Visibility is Critical

Surface grinding—and all the other critical grinding jobs—call for good visibility at all times. You've got to have it to do a good job . . . and you get it—with Houghto-Grind, Houghton's chemical grinding concentrate.

Houghto-Grind is completely clear. It's made to order for jobs that have to be watched closely every second.

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Houghto-Grind is long lasting. It prevents rust, both in machines and on freshly finished work. It is antiseptic treated, will not turn rancid, and you can dispose of it without worrying about pollution.

Because you normally use Houghto-Grind in dilutions of 100 to 1 or higher with water, it's also an outstanding money-saver. Ask your Houghton Man about Houghto-Grind today—or write E. F. Houghton & Co., 303 West Lehigh Avenue, Philadelphia 33, Pennsylvania.

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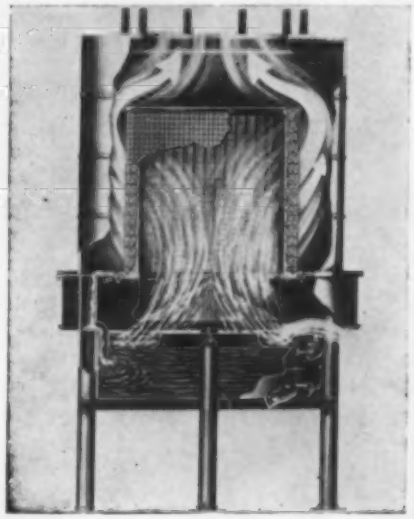
Circle No. 229 on postpaid card

New Oil Bath Air Filter Features Low Pressure Loss

A new oil bath air filter which combines high efficiency with extremely low pressure loss has been announced by the Air-Maze Corp., 25000 Mile Rd., Cleveland, O. The new LPD achieves low-pressure-drop operation without any moving parts or any outside energy supply. The result will be to make economical oil bath filtration available for use with a much broader range of compressors, blowers and engines.

Oil scrubbing has long been an accepted method of cleaning intake air, but in the case of some equipment (such as turbocharged stationary engines) the



energy required for oil-bath filtration—in the form of static pressure loss—has been too great to tolerate. Until introduction of the LPD filter, the only solution was to supply the required energy from an outside source in the form of a moving curtain or motor-driven oil pumps.

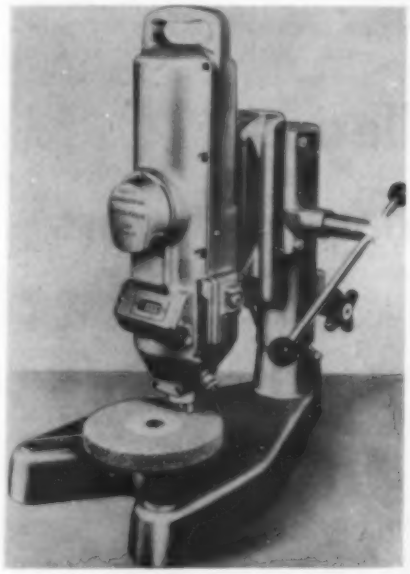
The new filter reduces energy requirements, making it possible to eliminate power-consuming motors and all other moving parts with their wear and maintenance problems. This was accomplished by reversing the conventional oil and air circuit. Air is drawn in under a weather hood set low on the unit and is directed through an air-flow regulator tube to an oil control pan. Here the air picks up droplets of oil which are carried up through a diffuser cone where air and oil are thoroughly mixed and air is scrubbed. The air then passes through the cylindrical filtration element where dirt particles and oil droplets are removed, permitting only clean, oil-free air to flow to the engine, blower or compressor. Oil and the dirt it has collected flow down inside the filtration element and through oil-return pipes to the sump where dirt settles out. •

Use HANDY Postpaid Card. Circle No. 112

Process Hardness Tester for Grinding Wheels

A new testing machine for determining the hardness of grinding wheels is being manufactured by the George Scherr Co., Inc., 200 Lafayette St., New York 12, N.Y.

The machine is designed to produce a dynamic test by means of a reciprocating and rotating chisel held under a certain pressure. The combination of pressure exerted, the number of recipro-



cating strokes, and revolutions of the chisel at the moment of impact, are as similar as possible to the actual stress to which the grain imbedded in the wheel is subjected in actual use. The test records the number of strokes of the revolving chisel, required to reach a penetration of 3 millimeters. The force subjected to the grinding wheel grain is therefore a partly hammering and partly scraping one, very close to the force to which the wheel is normally subjected.

The test includes first, stroke frequency recorded on a counter. Second, chisel rotation at the moment of impact. Third, hitting force of the chisel, which is constant, and a depth of penetration of 3 millimeters.

The new process hardness tester will solve many uncertainties now existing. The most prevalent method now in use is the testing by hand involving a steel chisel, similar to a screw driver. This hand tool is pressed vertically or at an angle on to the wheel body to be tested and rotated until single grains are loosened and breaking out. The force required is then usually determined by the educated feel of the operator to whose judgment it must be left to grade the wheel for hardness. •

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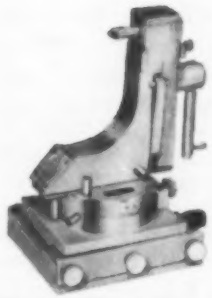
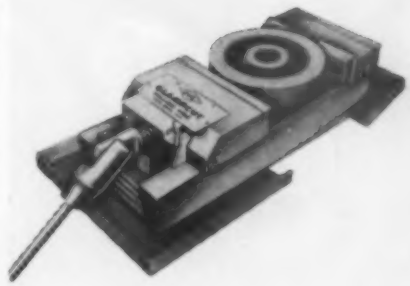
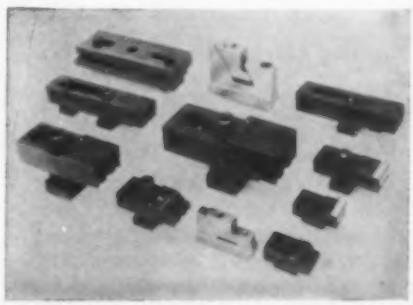
J&S DOWN-HOLDING DEVICES and WHEEL DRESSERS LEAD THE FIELD



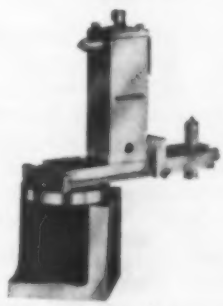
Fluidmotion Wheel Dressers—Dress two angles tangent to a radius, using ONE handle in one continuous motion. Operation is so fast and simple that beginners can use them. For all types cylindrical and surface grinders.



J & S Swivel Vise—The only hardened and ground swivel vise that mounts low, swivels, needs no pedestal. Patented down-holding clamping jaws give many times the holding power of an ordinary vise, yet only half the weight.



J & S All-Purpose Jaw Clamps — For any machine table or face plate. Five models—one adjusting screw has a holding force of 2½ tons on Small model, 12 tons on Jumbo model. Eliminate u-clamps, straps and fingers. No obstruction problems, no interference with measuring tool readings.



J & S Form-Master—Sturdy wheel dresser for shops with less frequent wheel dresser requirements. High quality, 100% dust-proof, it is capable of dressing any radii up to 12″ convex, up to 15″ concave.

WRITE FOR INFORMATION ON THE NEW J&S PURCHASE PLAN

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Available Literature

Catalogs and Bulletins Available from Manufacturers

For copies of the literature in which you have an interest use the postage-paid postcard. Merely circle the identifying number and mail the postcard.

1. Cutting Fluids. The Johnson's Wax Co., Dept. GF, Industrial Products Dept., Racine, Wis., has announced a new booklet entitled Cutting and Grinding with Johnson's Wax Cutting Fluids. Booklet describes the properties of wax as they assist the cutting functions of the metalworking industry. Booklet also gives a complete description of all Johnson cutting and grinding water soluble coolants and cutting oils plus a comparative machinability table as a guide to selecting the correct coolant for every grade of metal.

(See Number 1.)

2. Optical Comparator Charts. Catalog No. 403, available from Jones & Lamson Machine Co., Dept. FF, Springfield, Vt., describes their complete line of charts for optical comparators. A basic set of comparator master reference charts will provide your comparator with increased versatility. In many cases a standard chart will permit full inspection to be made on comparator models that do not have complete measuring facilities. The line of optical comparators and accessories is also described and illustrated.

(See Number 2.)

3. Surface Grinder. Abrasive Machine Tool Co., Dept. RG, East Providence, R.I., has announced a new catalog describing and illustrating the new No. 618 hand feed precision surface grinder (6″ x 18″ x12″). Catalog describes the many new features and operational advantages engineered into the new surface grinder.

4. Honing Machines. The complete line of honing machines and accessories are included in a new catalog available from Superior Hone Corp., Dept. F, Elkhart, Ind. Also included is the Superior Model C portable coolant unit which converts any dry honing machine to a wet unit. Mandrels, stones and special machines are also featured.

5. New Bay State Price Catalog. Bay State Abrasive Products Co., Westboro, Mass., has a new price catalog available, replacing all previous price lists with the exception of the Diamond Wheel catalog and Abrasive Products for the Building Trade. All other pricing catalogs, discount sheets, price change notices, and miscellaneous pricing forms now in your possession can and should be destroyed.

6. Deburring and Chamfering. Cogsdill Tool Products, Inc., Dept. G, 12980 W. Eight Mile Rd., Oak Park 37, Mich., has available a booklet describing the usage of BurrAway and BurraMatic tools. In the data sheets various applications, methods and procedures are outlined to serve as a guide in applying these tools.

7. Industrial Brushes. A new illustrated catalog available from Pittsburgh Plate Glass Co., Brush Div., Dept. GF, Baltimore 29, Md., gives 12 examples how Pittsburgh industrial brushes saved industry money. The brushes are used for cutting, polishing, smoothing, cleaning or removing metal and are shown in operation in 12 typical installations.

8. Centerless and Cylindrical Grinding. Precision Grinding Wheel Co., Inc., Dept. RG, Philadelphia 36, Pa., has a new booklet available showing modern trends in centerless and cylindrical grinding through the use of Precision grinding wheels. Booklet is designed to acquaint you with the research and development that goes into Precision grinding wheels.

9. Die Filer. Bulletin No. 256, available from Sales Service Machine Tool Co., Dept. F, 2363 University Ave., St. Paul, Minn., illustrates and describes the Keller die filer which is available in three models. This unit is designed for filing, sawing and lapping operations. Complete specifications are given.

10. Wheel Dressing Tools. The Koebelite line of wheel dressing tools are featured in literature available from Koebel Diamond Tool Co., Dept. RG, 9456 Grinnell, Detroit 13, Mich. These tools made with concentrated diamond particles are composed of uniformly distributed diamond particles securely held in position by means of a newly developed Koebelite powdered metal matrix.

11. Ballizing. Industrial Tectonics, Inc., Dept. FF, 3684 Jackson Rd., Ann Arbor, Mich., has literature available describing the ballizing process for high-speed, high-precision hole sizing and finishing. This process does not remove any metal, but operates by a burnishing action which compresses and smooths the surface by cold-working a thin layer of the hole wall material.

12. Copy Grinding Machine is described in a new folder available from the Carl Hirschmann Co., Inc., Dept. GR, 30 Park Ave., Manhasset, N.Y. It describes the method used for grinding two duplicate lathe tools, form tools, thin profile gages, or production parts

(See Number 5.)

simultaneously on the new Copyrex grinding machine.

13. Dust Collector. The Green Fuel Economizer Co., Inc., Dept. G, Beacon, N.Y., is now manufacturing and offering for sale a packaged type Aerodyne dust collector, which is described and illustrated in bulletin 172-CFF. The company also makes a complete line of cinder traps, draft fans and economizers.

14. Diamond Wheels. Allstate Diamond Products, Dept. GG, 80-82 Bowery, New York 13, N.Y., has a new catalog available describing and illustrating their complete line of diamond wheels and hones. Catalog contains complete specifications and information needed for ordering.

15. Deburring and Finishing. The Almco Div. of Queen Stove Works, Inc., Dept. GR, Albert Lea, Minn., has a folder available describing and illustrating their complete line of barrel finishing equipment, fixture machines, handling and separating equipment.

(See Number 3.)

(See Number 4.)

(See Number 6.)

Complete specifications are given for all units.

16. Flute Grinder. Bulletin No. 654, available from the Edward Blake Co., Dept. F, 437 Cherry St., West Newton 65, Mass., describes and illustrates the Blake flute grinder. By keeping taps sharp, considerable savings can be expected. When reground at the critical point just before wear starts, the life of the average tap can be extended six times or more.

17. Diamond Powder and Compound. A complete price list of diamond powder and compound is available from Diamond Tool Research Co., Inc., Dept. GF, 380 Second Ave., New York 10, N.Y. Advantages of compound over powder and powder over compound are explained along with how they are made and packaged, color-coded and guaranteed.

18. Grinding Wheels. The DoAll Co., Dept. FG, Des Plaines, Ill., has available a catalog section covering their full line of surface grinding and bench grinder wheels. Literature contains data explaining the meaning of grinding wheel code numbers or markings. Composition and applications of fundamental types of wheels are described.

19. Optical Comparator. Bulletin 1456C, available from Covel Mfg. Co., Dept. GG, Benton Harbor, Mich., describes and illustrates the No. 14 optical comparator, which permits quick economical precision inspection right out in the shop. This unit is claimed to be ideal for shops using mechanical means of measuring because of the expense involved.

20. Deburring Machine. Chicago Wheel & Mfg. Co., Dept. FG, 1101 W. Monroe St., Chicago, Ill., has literature available describing and illustrating the Handee Slide-Abrader which is engineered to produce low cost deburring, radiing, and finishing of small parts for screw machine, machine shop, die cast and stamping departments.

21. Belt Grinder. Literature available from The Engelberg Huller Co., Inc., Dept. F, Syracuse, N.Y., describes and illustrates the Model WG4 wet-dry belt grinder for platen or contact wheel grinding. The WG4 incorporates a built-in coolant tank, filtering and settling system, coolant pump, piping and spray nozzles, all started and stopped from one switch.

22. Oscillating Tool Grinder. Bulletin describes the new Poweramic oscillating tool grinder manufactured by Wesson Co., Dept. RG, 1220 Woodward Heights Blvd., Detroit 20, Mich. It is designed for off-hand grinding of standard and special single point carbide tools. It is claimed to take the skill and effort out of grinding carbides, boost output and give a fine finish.

23. Blast Cleaning. The use of airless abrasive blast cleaning on shell molded castings is the subject of a new brochure available from Wheelabrator Corp., 1169 S. Byrkit St., Mishawaka, Ind. Booklet illustrates case histories where airless abrasive blasting is used and gives performance rates.

24. Contact Roller Spindle. Columbia International Corp., Dept. FG, 10-35 44th Drive, Long Island City 1, N.Y., has literature available describing and illustrating the Wagner contact roller spindle, manufactured by the Ferd. Wagner Co. of Western Germany. This high speed internal grinding spindle has a maximum speed of 200,000 rpm.

25. Liquid Honing. Vapor blast liquid honing is described in literature published by Vapor Blast Mfg. Co., Dept. G, 3025 W. Atkinson Ave., Milwaukee 16, Wis. This method of surface finishing uses fine abrasive powders (40 mesh to 5000 mesh sizes) suspended in a chemical solution and forced at high velocity through special nozzles against the surfaces to be treated.

26. Lapping Service. Literature from the Van Keuren Co., Dept. GF, 176 Waltham St., Watertown, Mass., describes their complete lapping facilities. They can deliver lapped or polished surface finishes in the order of .5 to 5.0 rms, or dimensional tolerances from .000001" to .0001". They have facilities to lap flat and cylindrical work in both metals and non-metals.

27. Coolant. Vitene Mfg. Co., Inc., Dept. RG, 230 E. 8th St., Mount

ONE Drill Grinder Sharpens ALL Drills

- 90° to 140° Included Angle
- 1/8" to 2 1/2" Diameter
- 2-3-4 Flutes
- Without Chucks or Collets

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STERLING Model "DV" Variable Angle DRILL GRINDER

This Tool & Cutter Grinder has BIG CAPACITY

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Advice on Tumbling and polishing problems

21 Francis St., Worcester, Mass.

Vernon, N.Y., has literature available describing Vytron, the new transparent chemical coolant containing no petroleum, mineral, or vegetable oils, and which is completely soluble in water. By varying the strength of Vytron, a wide range of metals can be cut.

28. Dust Collectors. The complete line of Torit cabinet cloth filter and cyclone separator type dust collectors is pictured and described in a new catalog recently issued by Torit Mfg. Co., Dept. GG, St. Paul, Minn. Included in the literature are reasons why dust collectors are essential to industry, how unitized collectors save money and how they can be used.

29. Saws. Catalog 1235, available from Ty-Sa-Man Machine Co., Dept. GR, Knoxville, Tenn., describes the complete line of friction, abrasive, cut-off and long cut saws. Folder contains information on all the new models and latest adaptations, along with complete construction features and specifications.

30. Air Gage. The Taft-Peirce Mfg. Co., Dept. G, Woonsocket, R.I., has literature available describing air gaging and how to lower costs. This folder deals not only with automatic gaging as applied to mass production operations, but also points out semi-automatic and manual operations where air gaging can be used to advantage.

31. Flexible Shafting. A new 12-page engineering bulletin on the selection of flexible shafting is available from Stow Mfg. Co., Dept. RR, 443 State St., Binghamton, N.Y. Bulletin contains design information on all sizes of flexible shafts from ⅛" to 1⅝" in diameter for both power drive and remote control applications.

32. Test Indicator. This instrument is useful for both the setting up of work on a surface plate and the truing of pieces in machine tools. Due to the mounting arrangement this one instrument will serve all useful cases with adequate visibility of the dial, obviating the need for any additional instrument with dial perpendicular. Standard Gage Co., Inc., Dept. GF, Poughkeepsie, N.Y.

33. Radial Relieving Attachment. Spati Industries, Inc., Dept. RG, P.O. Box 501, Covington, Ky., has literature available describing their new radial relieving attachment. This approach to radial relief grinding utilizes the flute face to generate any amount of radial relief or combination of radial and axial relief. This attachment is not dependent on cams, consequently periphal runout due to errors in flute spacing in relation to cam lobe spacing is eliminated.

VISUAL GRIND

TOP FIRMS SHOW
PROVED SAVINGS UP TO 75%
IN SET-UP AND GRINDING TIME WITH CONTINUOUS WORK INSPECTION AND INFINITE PRECISION

Working with TUNGSTEN CARBIDE, STAINLESS STEEL, STELLITE or TOOL STEELS—VISUAL GRIND will permit a semi-skilled operator to grind precision pieces without continued checking with the tool room—since this function is done by the built-in optical comparator. Fill in the coupon below—let us show you how VISUAL GRIND will speed production—cut costs.

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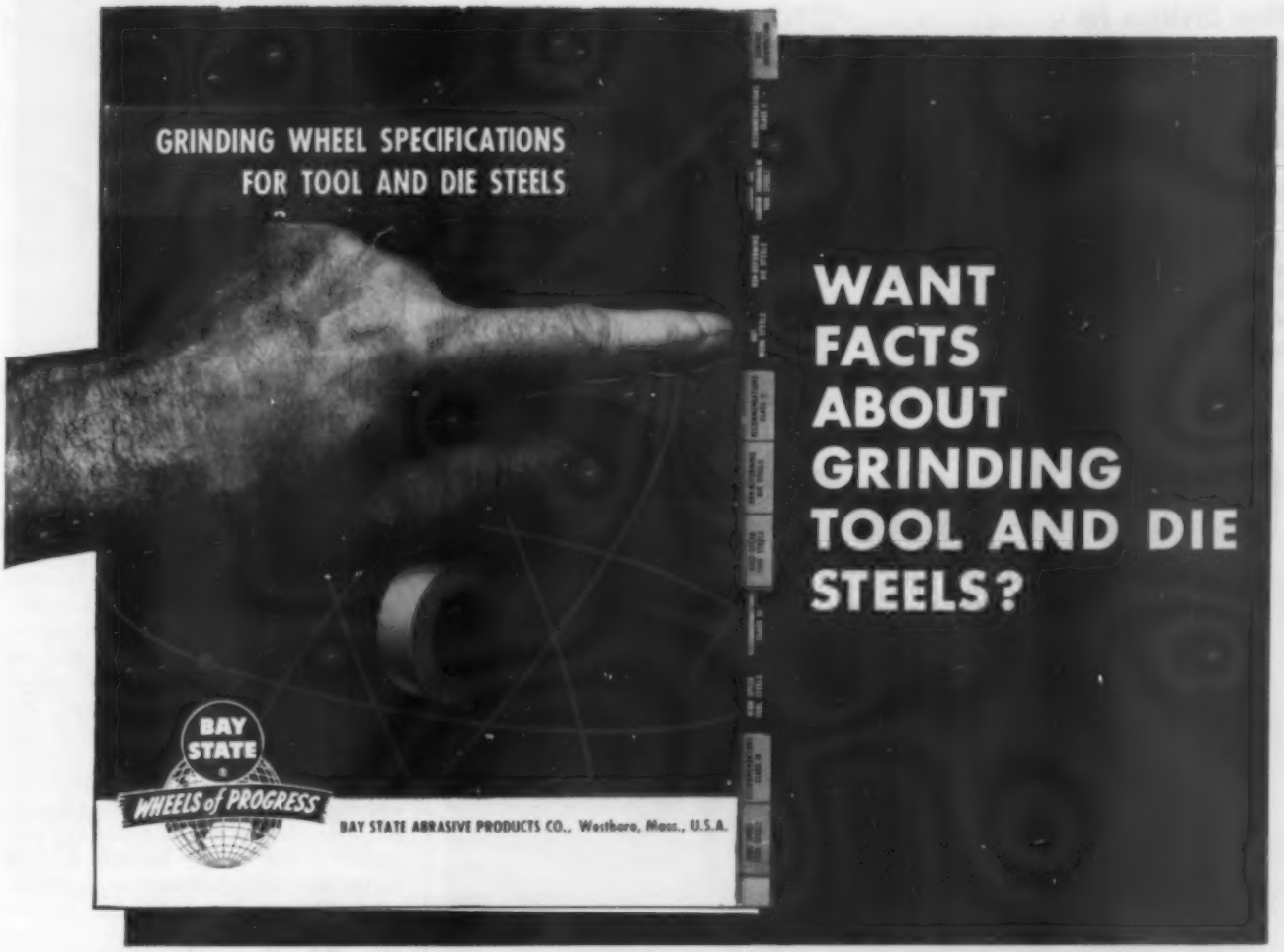
GRINDING and FINISHING Given Safety Award

Each year the National Safety Council awards plaques to those magazines, radio, TV stations and newspapers which have, in the Council's estimation, served the cause of Safety. GRINDING and FINISHING is pleased and honored to receive an award for its series of safety articles. In a letter, informing G and F of the award, Ned Dearborn, president of the Council, says in part ". . . As you know, the award is not competitive. It is designed to allow us to express in tangible form our appreciation for exceptional service to safety."

Shown below are, left to right, Henry Smith, vice president and sales manager, Bill Schleicher, vice president and editorial director, receiving the award for G and F, and Arthur S. Kelly, Power Press & Forging Section, National Safety Council, making the presentation. A photo of the award is shown below.


GRINDING WHEEL SPECIFICATIONS
FOR TOOL AND DIE STEELS
BAY STATE
WHEELS of PROGRESS
BAY STATE ABRASIVE PRODUCTS CO., Westboro, Mass., U.S.A.
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BAY STATE gives you these facts arranged for ready reference, in this new visible-index form. You can quickly locate the types of steel you use, and the recommended specification for grinding each.

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New Division for B. W. McIntyre Co.

The B. W. McIntyre Co. of Reseda, Calif., has announced the formation of a new barrel finishing division, called the Ultra-Sheen Metal Finishes Div. It is headed by Golden Latshaw, formerly of Cleveland, O., who, with almost 30 years of service to the metal finishing trade in the mid-west, has the necessary training and experience required for the solution of the many problems encountered by barrel finishers.

The division has developed new compounds for barrel finishing zinc and magnesium as well as a complete line of compounds for work previously proven adaptable for barrel finishing. Another innovation is a chemically-inert, triangle shaped media for use on parts where the chemicals deposited by standard media are objectionable, or where standard media tends to lodge. With the Ultramic media, zinc and other white-metal parts can be inexpensively finished.

Many firms with elaborately equipped barrel finishing departments, have gone back to the old, costly procedures of hand deburring and burnishing. It has been discovered that barrel-finishing was abandoned because of the lack of properly trained key personnel to supervise such departments.

Shown is a submersible unit, one of the many machines available from Ultra-Sheen Metal Finishes Div., along with a complete line of compounds and media.

Ultra-Sheen has gathered a staff of metal finishing consultants, who, under direct supervision of Latshaw, are placed in shops of firms desiring this service. The consulting force surveys parts in process, points up adaptability to barrel finishing and sets up efficient methods and procedures, trains key personnel in the proper techniques, and makes recommendations, complete with cost analysis and comparisons.

New Distributor for Armour and Company

Armour and Company, Coated Abrasives Div., Alliance, O., has appointed Willaid H. Johnson Tool Supply Co., 319 Illinois Oil Bldg., Rock Island, Ill. as an authorized distributor of their sheets, belts, discs, rolls and specialty products.

Norton Co. Sponsors Educational Assistance Program

An educational assistance program for its full time employees has been announced by Norton Co. The program is designed to recognize the interest of employees in taking additional courses of evening study which will provide useful background for their present jobs or prepare them for future responsibilities.

Under the plan, which becomes effective September 1, Norton will refund 50% of the tuition, registration and laboratory fees. A maximum of $200 may be paid to any employee during a twelve month period. The student must complete his course with a passing grade to qualify for the refund.

Courses must be given in an accredited school, college, or other educational institution approved by the Employee Assistance Committee.

ARTER also makes a HIGH one

Vertical capacity of Arter Model B Hydraulic Rotary Surface Grinder can be increased 24" using a raising block. So, for grinding surfaces on such work as the crankshaft housing for the piston-type airplane engine, as shown, Arter has the answer. Arter has been building rotary surface grinders for nearly forty years. Model B is built in four sizes — 20", 24", 30" and 40" diameters.

Whatever your surface grinding needs, Arter can meet them.

ARTER GRINDING MACHINE COMPANY

WORCESTER 5, MASSACHUSETTS

Jigmatic Automatic Tape Controlled Positioning Table • Rotary Surface Grinders
Flat Circular Cutter Grinders • Internal Grinders • Cylindrical Grinders • Carbide Tool Grinders

AGENTS IN INDUSTRIAL CENTERS OF UNITED STATES AND CANADA

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New List Price Catalog Announced by Bay State

Bay State Abrasive Products Co. of Westboro, Mass., has announced the availability of a new list price catalog that became effective July 2nd.

This single volume replaces all previous and current Bay State pricing material except the Diamond Wheel Catalog (Form 461), and Abrasive Products for the Building Trade (Form 531), which will remain effective until further notice. All other forms should be destroyed.

In this new book, most of the special wheel shapes can be priced in the same simple manner as the straight wheels. It is not necessary to compute the usual extra list price additions for most of the special shapes. Moreover, it is not necessary to compute the standard arbor hole allowances for either straight or special wheel shapes with arbor holes 6" and over. They have been included in the appropriate tables.

This new catalog is not a notification of price changes. It is, however, a notification of a change in the method of pricing Bay State products.

Grinding Wheel Industry Hailed as Key to All Industrial Output

Though a comparatively small segment of industry, grinding wheel production is the key to virtually all industrial output in the U. S., according to Grant S. Diamond, president of the Grinding Wheel Institute. He described the industry as a modern Atlas supporting the free world.

In addressing the three-day institute conference in Florida, Diamond, president of Electro Refractories & Abrasives Corp., pointed out grinding wheels are basic tools of almost all major industries, including metal, rubber, automotive, aircraft, mining, woodworking and shipbuilding.

Without modern grinding implements, he said, America would lose the mass production techniques which tilt the balance of industrial power towards the free world and away from communism.

Diamond predicted that grinding wheel production figures in 1956 will top even the records set last year, for the wheels are as vital to peacetime prosperity as to defense production.

New Name for Carboloy Dept. of General Electric

Since June 1956, Carboloy Dept. of General Electric Co. has been known as the Metallurgical Products Dept., to reflect the company's greater emphasis on specialty metals development and manufacture. Department headquarters will remain in Detroit.

General Electric expects continued growth in this field and, according to K. R. Beardslee, department general manager, "this concentration of metallurgical efforts will place the company in a far better position to convert into commercial products its extensive research into basic metallurgical problems."

Beardslee pointed out that the General Electric Company recently announced the opening of a new $5 million metallurgical and ceramics laboratory in Schenectady, N.Y. Already, he said, products are being manufactured in Detroit which are developed in this laboratory.

"This type of investment, coupled with the further development work conducted in metallurgical laboratories at Detroit and Edmore (Michigan) is greatly increasing the depth and potential of this part of our business," he added.

The two major products of the department are Carboloy cemented carbides and Alnico permanent magnets. Cemented carbides are used for metal-cutting and forming, magnets in electrical circuits and mechanical holding applications.

Present plans call for a doubling of the department's cemented carbide and permanent magnet businesses during the next 10 years.

A Coolant that Won't Stain Aluminum!

INTERNATIONAL 131-A

For grinding and cutting aluminum, International 131-A out-performs on every count. This stain-free coolant does not discolor aluminum or its alloys, nor does it react with aluminum dust. A superior finish is assured. In addition, the need for wheel dressings is greatly reduced . . . tool life is substantially increased.

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When writing advertisers please mention GRINDING and FINISHING

New Barrel Finishing Laboratory for Almco

R. C. Trow, vice-president, Almco Div. of Queen Stove Works, Inc., has announced completion of a complete barrel finishing research and development laboratory located at Albert Lea, Minn. headquarters for the Supersheen line of barrel finishing equipment and supplies.

Purpose of the laboratory is twofold. First, it offers the metalworking industry a modern facility for determining, without obligation, the most effective deburring and finishing methods for all types of parts. Sample processing of actual parts will be offered free of charge to manufacturers. Second, it provides the industry with latest machines and equipment for advancement of barrel finishing research.

Norton Co. Controls Argentina Sandpaper Plant

Norton Company has acquired controlling interest in a sandpaper plant in Argentina.

Located in downtown Buenos Aires, the firm is known as C.A.L.E. (Compania Argentina de Lijas y Esmeriles). Employing 50 people, it occupies about 16,000 sq. ft. It is privately owned and one of the two leading manufacturing concerns in Argentina producing all types of abrasive papers and cloths.

In announcing the purchase, A. Donald Kelso, president of Norton Behr-Manning Overseas Inc., said, "We acquired this plant in order that we might get into the Argentinian market which had been closed to us during the Peron regime. We will introduce at once American techniques and manufacturing controls, plus new equipment, to increase capacity and to better serve the growing demands of the Argentine industry." Management of the new company will remain in the hands of the present Argentinian group.

Norton Appoints New Distributor

Norton Company has announced the appointment of Rudel Machinery Co., Inc., of 100 E. 42nd St., New York, N.Y., as distributor for precision grinding and lapping machinery in eastern New York, northern New Jersey, Connecticut and western Massachusetts.

The appointment of the Rudel Machinery Co. will supplement Norton's own direct sales activities which have been carried on in those areas from the Teterboro, N.J. sales office.

These improved NIELSEN live centers for **grinders** are fitted with deflectors to protect bearings from grinding compounds. Have adjustment to take up wear and preload bearings.
This special **grinding** center available with any size point desired. Any size or type taper shank. Complete details and folder furnished on request.

Live Centers

Nielsen, Inc. Lawton, Mich.

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Page after page shows the correct abrasive wheel to use

(for the best Blanchard grinding results)

Blanchard wheels in silicate, resinoid and vitrified bonds.

This is our famous booklet *The Art of Blanchard Surface Grinding* — brought up-to-date with a third edition. It contains complete descriptions of our silicate, resinoid and vitrified bonded wheels. It also describes a number of jobs and shows you how to select the correct wheel for each job. Every Blanchard operator should have a copy handy — send for yours today.

Blanchard wheels are guaranteed for uniformity of grade. They're best for Blanchard grinders, best for every job. They give you maximum production, utmost economy . . . whether the work is tough as copper or fragile as glass, whether it requires heavy roughing cuts or precision grinding within .000010" of absolute flatness and surface finish of 1 micro-inch.

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64 State St., Cambridge 39, Mass.

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JIG GROUND
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A five station indexing fixture from Vulcan's Contract Tool Room (Your tool room in Dayton).

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*Vulcanaire equipment pays for itself on the first job.

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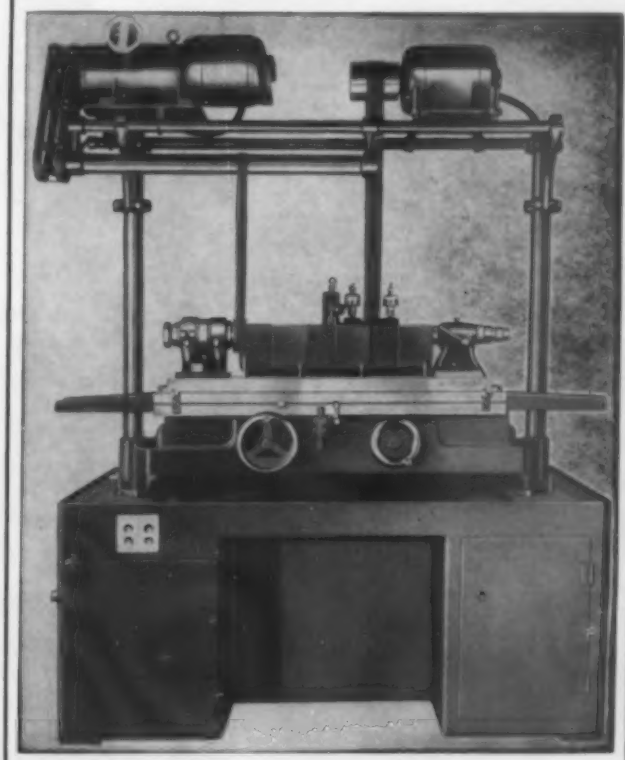
Your 1956 Crystal Lake Grinder can be equipped with Rex Super Van High Speed Steel, double taper spindles. Due to their high hardness, high tungsten content, spindles will run without clearance in bearings after they have been stabilized and ground to .000005 in. roundness. Spindles are set in boxes with heavy oil drag, and, DUE TO THE NINETY DEGREE OVERHEAD DRIVE, AMPLE POWER CAN BE USED TO ROTATE SPINDLE WITHOUT HEADSTOCK AND WHEELHEAD BECOMING CUMBERSOME AND HEAVY TO MOVE FOR SHOULDER GRINDING, ALSO, BELT PRESSURE IS NINETY DEGREES FROM GRINDING PRESSURE.



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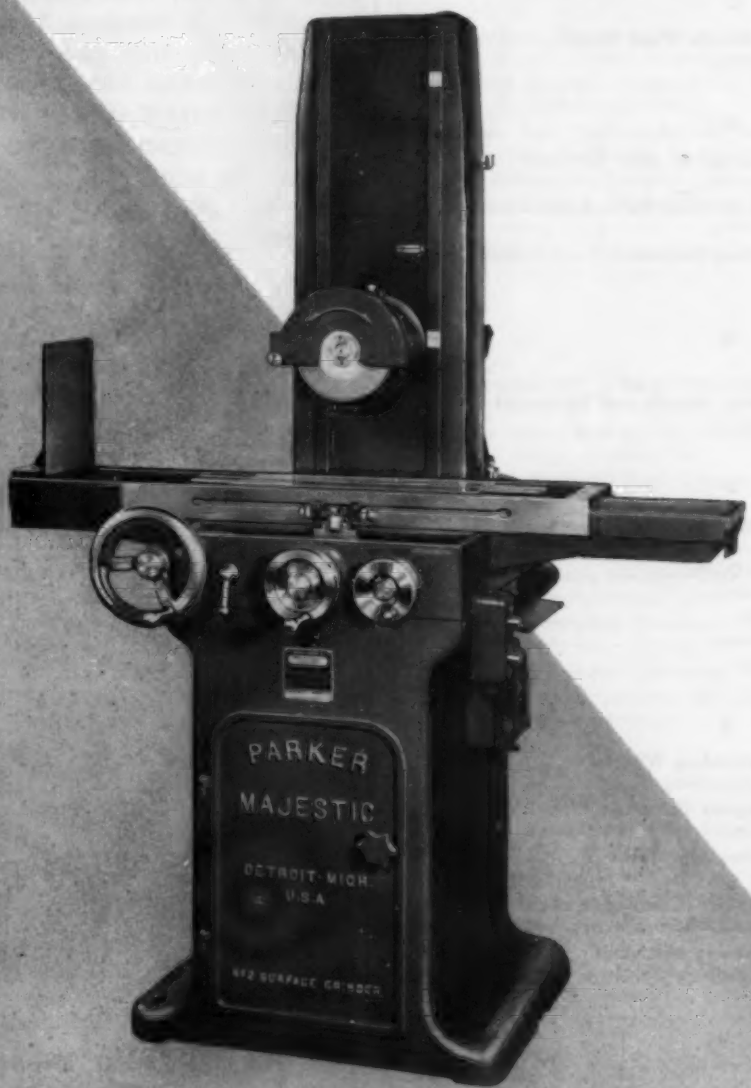

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Motorized drive for rapid spindle elevation.
Handwheel graduated directly in .0001″ increments.

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Sharpening tools and cutters like this milling cutter is cooler, easier with Sterling vitrified cup wheels.

"Wheels of Industry"—Vitrified and Resinoid—to meet the exact requirements of industry.

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